THE

ELECTRICAL REVIEW.

VOL. LIII. SEPTEMBER 18, 1903. No. 1,347.

"ELECTRICAL REVIEW."

Vol. LIII.] CONTENTS: September 18, 1903. [No. 1,347.

	Page
Street Traffic Problems	445
The Central Station Battery (*illus.*)	448
The Trades Union Congress	448
Our Legal Query Column	449
The British Association:—	
Street Traffic Problems	449
The Use of Aluminium as an Electrical Conductor	450
The Electrical Conductivity of certain Aluminium Alloys as affected by Exposure to London Atmosphere	451
The Reversibility of Thermodynamics	452
New Moving Coil Instruments and Testing Sets (*illus.*)	455
The Electrical Outlook in Germany	456
Correspondence	457
Business Notes	460
The New Electricity Works of the Manchester Corporation (*illustrated*)	463
A Private House Plant (*illustrated*)	465
Cheap and Satisfactory Construction	466
City Notes	473
Stocks and Shares	474
Share List of Electrical Companies	475
Market Quotations	476
Electric Tramway and Railway Traffic Receipts	476
The Gas Engine and its Future (*illus.*) (*cont.*)	477
Protection: A Reply to Mr. Byng (*concluded*)	478
Reviews	480
The Continental Electrical Engineering Industry	481
On a New Method of Tuning Wireless Telegraph Stations by Means of the "Multiplier" (*illus.*) (*concluded*)	482
The Evidence on Municipal Trading	483
New Patents Applied For, 1903	484
Published Specifications	484

THE

UNIVERSAL ELECTRICAL DIRECTORY

1903 Edition

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STREET TRAFFIC PROBLEMS.

COL. CROMPTON is nothing if not interesting, and in his paper on street traffic problems, which he has just read before the British Association, he puts before us several points which are undoubtedly deserving of some consideration. He is of the opinion that in spite of the great increase in transportation facilities, a journey of any distance through the streets of a large town to-day, is more annoying and wasteful in time than it was 40 years ago. This is no new discovery, and the self-evident fact is probably the direct result of the improvements in methods of communication which have taken place during this period. The greater the facilities given to the public to travel, the more they will use them, and, consequently, the more difficult the solution of the problem of rapid transit becomes. This has been clearly demonstrated during the last few years in New York City.

Col. Crompton divides the traffic of our large cities into two sections, namely, wheeled and pedestrian traffic; he refers to the various sources of irregular traffic caused by people of leisure, who either walk or drive through the streets for exercise, shopping, visiting or sight-seeing, and he states that, in his opinion, this is one of the most difficult portions of traffic to control. We think he greatly exaggerates this difficulty; in London it is the heavy van and 'bus traffic which, in our opinion, is the most difficult to handle, and although police regulations exist, intended to separate fast and slow traffic, heavy vans and 'buses are still hopelessly mixed up with the faster carriage, tramway and motor-car traffic.

The author wishes that walking traffic on the footways should be free from obstruction, so as to allow of great variations of speed, or, in other words, to turn our footways into wider paths. Apparently he objects to the attractions of the shop windows which, we take it, he would like to abolish. Our experience of the London foot-ways does not agree with Colonel Crompton's; even in the busiest hours of the day a reasonable walking speed is always possible, although to run along the footways would probably be difficult, and is, to our mind, quite unnecessary. We quite agree with the author of the paper that something should be done to facilitate and quicken the enormous existing wheeled traffic of London, but we cannot see that another police department, and consequent additional "red tape," would be of very great assistance in advancing the solution of the problem. We think that greater powers should be conferred on the police, and that some of the existing rules regarding separation of fast and slow traffic should be much more rigidly enforced. The ideal conditions laid down in the paper are such that we are afraid they can never be attained in London, and in laying down these conditions, Colonel Crompton appears to have overlooked the question of traffic having to leave the main thoroughfares for a side street, or of carriages, auto-

mobiles, or 'buses having to stop to take up or put down passengers. We quite agree with him that it is absolutely necessary that stringent rules should be laid down so as to sort, and, as far as possible, divert, the slow traffic from the most crowded of our main thoroughfares. Rules should be enforced so as to minimise the waste of space when one vehicle overtakes and passes another, but Colonel Crompton's idea of requiring 100 yds. clear in front before a small-powered automobile could attempt to overtake a vehicle in front of it, is out of the question. Overtaking seems to us not only to depend on the accelerating power of the vehicles, but also to a large extent on the maximum speed which can be attained in different streets.

A very weak spot in the regulation of our London traffic is found in "the vehicles drawn up for unloading at right angles to the street," and we certainly feel that in certain of our streets which are not purely bordered by warehouses, but which are thoroughfares, this practice should not be allowed during the hours when the streets are used by the general public; in this we would go even further than Colonel Crompton, who apparently thinks that this prohibition should only apply to daylight hours.

To those who have to travel over the main roads leading out of London, the congestion caused by returning empties, such as heavy market garden vans, &c., is well known, and the heavy railway vans conveying goods to the various passenger and goods stations greatly add to this evil.

Colonel Crompton apparently favours the Continental courtyard and *porte cochère* system, but from our experience we consider that its introduction in our narrow London streets would do more harm than good. In connection with bicycle traffic, we have long thought that in crowded and congested streets, particularly on greasy asphalt and wood paving, bicycle traffic should be restricted, as cyclists —especially ladies—often become a great source of danger to others as well as to themselves.

The suggestions for relieving the congestion at crossings of main thoroughfares by means of "circuses" are theoretically very interesting, and would, of course, be quite practicable were a new London to be laid down to-day. With regard to his condemnation of the speed limit, and his contention that much greater safety and comfort would result if no speed limit were imposed, we think that for this to be practicable, it is necessary that vehicles should always be driven so as to be under perfect control, that they should be able to pull up within a given distance, the distance to depend on the density of the traffic in the streets; also the severest penalties should be enforced for driving to the danger of the public. The closing remarks of Col. Crompton seem to show that he has been rather unfortunate in his experience in London. We have walked at all times of the day and night along the main thoroughfares of London, and in very few instances have we had to complain of foot passengers not always keeping to the right. This rule has been practically carried out, and more or less enforced ever since we can remember London. The suggestion that the crossing of streets should only be allowed to take place at fixed points and under the superintendence and guidance of a special official, whom he calls a "crossing keeper," (we had nearly said sweeper), is one far too autocratic and savouring too much of German militarism to meet with our approval. The use of subways may slightly help matters, particularly in the case of women and children, but the additional trouble it would give to busy men, who compose a large proportion of the foot passengers, would ensure them being but little used.

Col. Crompton, in his paper, has not touched upon what we consider one of the most important points, namely, the influence of electric tramways. We much regret this, as had he done so we doubt not that his paper would have been even more interesting. A few remarks were made on the matter in the course of the discussion, and from the short summary appearing on another page, it will be seen that he regards the electric tramway, as at present laid, as little better than a great obstruction.

At present we cannot see that the public would benefit in any way by the replacing of electric trams with automobiles of any description. The carrying capacity per vehicle cannot be so great; the automobile must suffer always from having to carry about its own generator of power, or a limited store in weighty containers; while under equally good conditions the mean speed, the acceleration, and the braking power, will be no better on the large passenger automobile than on the rail-guided car.

In large cities suffering from congestion, the time will come when street traffic is subject to close regulation, and to as great division into speed and weight classes as the width of thoroughfares will permit, when widened to any extent which may be commercially practicable. Then there will be recognised points in the length of a street at which traffic may cross the tramways, which will be free from any interference by parallel traffic, and will be operated at speeds of 12 to 16 miles per hour. It seems probable that the trams will run on either side of the streets, as near to their customers as possible, although it will take a long time to break through the vested interests of the owners of carriages and business vehicles in the 9 ft. 6 in. strip set aside for them next the kerb for standing room.

That great improvements in the way of street widenings, new thoroughfares, isolation and regulation of traffic, will be carried out within this century, no one who has seen the progress towards these ends made during the last century will be prepared to doubt; but there is going to be no revolution, as some would have us think, only the usual evolution.

Refuse Destruction: Twenty-Five Years' Progress.

Under the somewhat ponderous title "Twenty-Five Years' Progress in Final and Sanitary Refuse Disposal," a paper was read in the Engineering Section of the recent British Association Congress, by Mr. W. F. Goodrich. Mr. Goodrich knows, probably, as much as anyone about the modern refuse destructor; more, perhaps, than he knows about flies, which useful creatures he roundly abuses. That disease may be carried by flies from refuse tips to houses, and from the rotting carcases of horses on the veldt to military camps is perfectly possible; but even were it absolutely proved to be the case, there is another side to the question, which is not decided by the off-hand exclamation "so much for the so-called harmless fly." It has been authoritatively stated that *three* of those despised muck flies would dispose of the carcase of a dead ox in less time than a lion could, due, of course, to their amazingly rapid multiplication.

Thousands of dead horses and cattle rotting on the veldt would, in the absence of these and other natural scavengers, have probably decimated South Africa; in comparison with which the deaths from enteric are a mere fly-bite. Similarly the deaths caused by the transmission of disease from refuse tips by flies are as nothing to the pestilences which would rage in the absence of these insects.

The author is on safer ground when he deals with data relating to refuse destructors. Twenty-five years ago destructors had been adopted in two towns; at the present time 180 towns are provided with them. Of these, 63 are combined with electricity works, and 40 with sewage works. Says the author, "The combination of a destructor with an electricity works has been the subject of much discussion, and has been very severely criticised; it may, however, be submitted that the most vehement critics have not stemmed the tide; on the other hand, criticism has done not a little toward removing misapprehension, and popularising the combination." Whoever else it may be popular with, it is certainly not with the electrical engineers who run the stations.

We have no criticism whatever to offer against the combination, so long as it is not sought to show that it is necessarily a profitable undertaking, and that to tack on a destructor to an electricity works means "Electricity from Rubbish," in the sense that the man in the street understands this expression.

Let us by all means utilise the waste heat from destructors, but do not let us say that the heat costs nothing. If nothing better offers, an electricity works is better than nothing. But if, in order to make the most of the refuse, we put down a destructor twice the size we otherwise should, so as to increase the power available; if we instal batteries of larger capacity than we otherwise should, in order to store the energy of the waste heat; the extra costs of these items, together with the cost of the boiler, which is not necessary to "final and sanitary disposal" of the refuse, together with the additional flues, economiser and other adjuncts, must be debited to the electricity works, if the steam itself is not charged for. Referring to our correspondent of last week, we agree with him in the main. Our point is simply this: To add a refuse destructor to an electricity works, and then to say that, because fuel costs nothing—the sanitary department delivering it free on site—it is a profitable thing from the electricity works point of view, is a statement that can only be true under special conditions, conditions in which the total costs of destruction are less than the cost of coal and coal firing would be.

We have no objections whatever to properly-designed combined stations, as such.

Wolverhampton's Sign-Post.

We can hear the occasional bumping of the Wolverhampton municipal craft as it is steered 'twixt innumerable rocks. The leading lights of the city have needed all the wisdom of the serpent in finding a way out of a difficulty of their own creating, and it is with a gasp of relief that we this week record the beginning of the end—of the first chapter—of the unfortunate surface contact tramway experiment. That the Council made a great mistake when its ambitions led it to try an untried thing, we have shown on more than one occasion; that there are few local Councillors, capable of judging, who are not heartily sorry for their error and wish the system were at the bottom of the sea, we do not for a moment doubt; but, above all, it has been demonstrated beyond dispute that other towns ought to profit by the failure of Wolverhampton. Surely so colossal a municipal rate-aided error is not likely to be imitated elsewhere! The company has, of course, striven throughout the negotiations to obtain the best possible terms for itself, and we are not sure that the Council has not been wise in agreeing with its adversary in the manner outlined in the report on the subject which appears in our "Traction Notes" to-day. If the decision which is to come before a gagged special Council meeting—specially gagged by the misplaced authority, as it seems to us, of the town clerk—is confirmed, it will avoid the vexatious, cumbersome and costly machinery of arbitration and law by paying £22,000 to the company with which, presumably, it then severs its connection.

But, as we have said, it is only the end of the first chapter. There will be many things to be said as time rolls along, particularly when the town finds itself handicapped in establishing facilities for inter-communication with lines worked on other systems.

Troubles in the "Tube."

"It never rains but it pours," and the Central London Railway has been singularly unlucky during the last two weeks; the disaster at Paris was, in less degree, a misfortune to the C.L.R., and has been followed closely by three mishaps of an annoying but fortunately not serious nature. The first of these was recorded in our pages last week; the other two took place on Thursday evening last week, and were of a similar character. At half-past six o'clock a train was being shunted from the up to the down line at the Bank Station, where the first accident occurred earlier in the week, and one of the coaches was derailed, cutting off the power current and causing a block. A trainload of passengers between the Bank and Post Office Stations had to walk along the track to the former, and arrived at the street level within ten minutes of the accident occurring. The service was renewed between the British Museum and Shepherd's Bush, but, as ill luck would have it, a similar accident took place at the British Museum cross-over at about 11 o'clock, and the temporary terminus had to be further transferred to the Marble Arch. The line was cleared during the night, and traffic was resumed throughout by 8 a.m. on Friday.

The cause of the accidents at the Bank Station seems to have been one which is well known to steam railway men, but was not anticipated in connection with the electrical trains; it depends upon the use of a motor-car at each end of the train. Obviously, if the motors are equally loaded, each motor-car will propel half the train, so that while the forward half is being towed, the latter half is being pushed; hence the two or three coaches at the rear of the train are to some extent deprived of the "friendly lead," so to say, that is given to those immediately following the leading car, and are free to take advantage of any irregularity in the track, such as necessarily occurs at a cross-over, and jump the rails. To avoid this in future, the forward motor will alone be used in shunting, and we have no doubt that this will put an end to the trouble.

The mishap at the British Museum Station is said to have been due to a broken switch, which fouled the points.

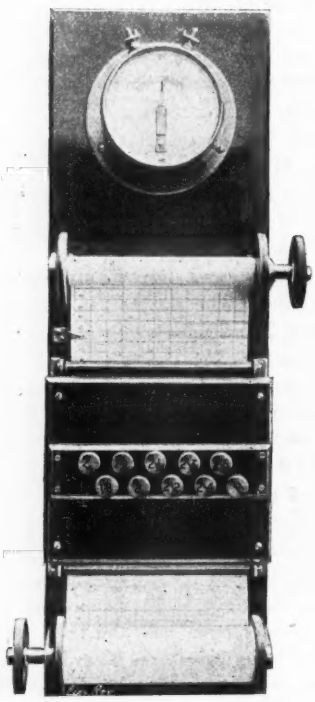
We have spoken of these mishaps as injurious to the railway company's interests. We are, however, by no means sure that we ought not rather to regard them as highly beneficial; for they have afforded opportunities for the display of the phlegm and freedom from panic which are inherently characteristic of the British race, on the part of the passengers, and at the same time they have demonstrated the fact that, while accidents may happen on our underground electric railways, they need not be regarded as likely to endanger the lives of the passengers, or even the property of the company. Moreover, the precautions taken by the latter, in the shape of oil lamps in the carriages, electric lamps in the tunnels, and a gangway between the rails, have been shown to be adequate for the purpose intended. In fact, we may even congratulate both the passengers concerned and the railway staff upon the excellent and reassuring results of these unintentional experiments, with the pious hope that the latter are for ever ended.

THE CENTRAL STATION BATTERY.

By A. J. ABRAHAM, A.M.I.E.E.

Should anyone visit all the direct current stations in the United Kingdom, which have been working for two years and upwards, he would be surprised to note the percentage of batteries which look as though they are almost ready for the scrap heap, and even more astonished to find that some of these have only been working for a little over two years. Now, although for the high initial cost the life of a first-class battery is an exceedingly short one, there is surely something very far wrong when well-known makes begin to collapse and shirk duty after a few years' work.

A central station has an advantage over private installations in the way it maintains all its plant with the exception of the battery, but I have seen it stated in a report by a well-known expert that the average battery in a private installation lasts in good condition nearly twice as long as the average one in a central station. The cause of this state of affairs is, without doubt, that the battery as it is now constructed has a very trying life for this construction in a



Walsall Cell Voltage Recorder.

central station. Unfortunately, in most cases this cannot be avoided without doing away with the sphere of usefulness of the battery, and until batteries with a much longer life and smaller maintenance cost can be manufactured to undergo the severe usage of a station they must be put up with as they stand. But surely the first cost of accumulators makes it worth while to treat them with great care and watch over them continually. Nothing goes wrong so quickly, one might almost say mysteriously, as an unwatched battery, and such a little thing is liable to cause the ruin of a cell; two plates will become partially shorted in some way—it may be through a dirty separating glass tube—the cell will, perhaps, gas with the others for quite a long while, but the volts at the end of each charge very gradually decrease until the positive plate becomes soft and buckles; then, perhaps, it is noticed, but more often than not the cell is allowed to become dead. Of course, this is neglect, which arises through not booking the volts of each cell *carefully* at least once a week. In too many cases are the volts of a battery taken here and there, and the others "just looked at to make sure they are gassing." The cause of this neglect and dishonesty is undoubtedly that to take and write down the volts of a large battery is a monotonous and arduous undertaking. On account of this, it is the practice in many stations to book a few cells every day at the end of the charge, so getting round the battery once a week. Anyone giving the matter a little thought will see that this method is entirely wrong; how can the volts of cells be compared, when one batch was taken one day and another batch the next? To properly go round and write down the volts of a battery consisting of, say, 280 cells, occupies one man for over an hour, and during this period current *is going to waste* through the battery. Messrs. The Walsall Electrical Co., Ltd., have now put on the market a patented cell recorder *which will record on paper the volts of a 280-cell battery within 13 minutes;* every cell below 1·8 volts will be marked "low," and every cell above 2·5 volts "high;" between this range 1·8 and 2·5 volts it will record to 0·1 of a volt. In use, the recorder is laid across the cell and a key pressed down as in a typewriter. This device, as will be seen, is both a time saver and a battery saver, as none but the absolutely worthless could fail to record the volts of a battery under such an easy and rapid method. In addition to this, it is a strong and simple device with no delicate mechanism to get out of order; there is no ink, as in most recording instruments, and the price is very low.

Such an instrument will save great sums as regards current, time and battery maintenance, for it is not ignorance concerning the way defective cells should be treated, but failure to catch these cells in time to treat them, which makes the battery almost a defect in our central stations. There are, of course, cases of incredible ignorance on the part of persons put in charge of accumulators, as I pointed out in a former article, but these are happily getting rare. However, two and a half years ago, a man responsible for a battery in a large station informed me that "battery makers had so improved the construction of their cells that it was now possible to get 2·7 volts per cell." It is interesting to note that at the present time this battery is being overhauled by the makers, although it is not three years since it was first erected.

THE TRADES UNION CONGRESS.

[from our special correspondent.]

Leicester, *September 12th.*

The thirty-sixth Trades Union Congress, which concluded at 11 o'clock this morning, has been remarkable for the high tone of the debates, the absence of "scenes," and the evident concentration of the labour forces on the capture of the legislative machinery. Underlying each resolution and expressed in nearly every speech was the belief that only in the return of labour members to the House of Commons lies the possibility of ameliorative legislation. An attempt to consolidate the forces necessary for this purpose could be found in the decision to establish a daily labour paper, and the enthusiastic endorsement of the work of the Labour Representation Committee. It is true that for the moment, at least, the machinery of the labour representation movement has been captured by the extreme wing of the trade union movement, and a policy of so-called independence which is interpreted as isolation has been adopted. But there are not wanting indications that the triumph of the Socialists is only temporary, and that ere long more moderate counsels will prevail. This fact, however, does not conceal the still more significant fact that all sections are bent on using their votes and money for promoting candidatures which shall favour labour legislation. Recent events have shown that this concentration will probably introduce into politics a new factor which will be almost revolutionary in its effects. Many subjects more or less germane to trades unionism were dealt with, such as the Bulgarian atrocities and international arbitration; and Mr. Chamberlain's new fiscal proposals were condemned in a most unqualified manner. The discussion on this latter question was very one-sided, and the decision was arrived at mainly on what one might call "bread and butter" principles, but the fact emerged that the organised workmen of Great Britain have a keen eye on the Colonial Secretary's policy, and, at present, are unanimously opposed to it.

As usual the Post and Telegraph employés were represented, the delegates in attendance being Messrs. C. H. Garland and E. J. Burt, Postal Telegraph Clerks' Association; Mr. Cheesman, Fawcett Association; Messrs. Stuart and Pratt, Postmen's Federation, and Mr. Lea, United Kingdom Postal Clerks' Association. Although these delegates supported certain of the broader questions, such as Compulsory Arbitration, there was only one resolution directly bearing on postal matters. This came up for consideration on Friday afternoon, and read as follows:—"That this Congress expresses its keen regret at the decision of the Postmaster-General to curtail the limit of special leave for the purpose of conducting the legitimate organisations among postal and telegraph servants, and in view of the

fact that such leave is granted at no expense to the State, and causes no delay to the public work, this Congress regards the action of the Postmaster-General as being directed against the right of postal servants to combine, and begs the Postmaster-General to sanction such arrangements as will give reasonable opportunities to the officials of the associations to transact their business." In proposing the resolution, Mr. C. H. Garland (London) said the resolution was one which touched very closely the fundamental principles underlying the Congress, viz., the right of combination among Government workers. There was no principle which the Congress guarded more jealously than the right of combination enjoyed by the workers represented there. At the last Congress in London it was decided that the Postmaster-General had put a slight upon the Parliamentary Committee of the Congress, and that he had refused the right of combination to his employés. He was not the only minister of the Crown who had taken up that attitude. Mr. Brodrick had done the same thing with regard to the employés of the Army Clothing Department, and he thought, therefore, they should enter a very strong protest against the many insidious methods by which ministers sought to deprive employés of the State of the rights enjoyed by outside workers. It was necessary that he should explain in what way the resolution pointed to an attack on the rights of combination. It must be understood that the Postmaster-General, in conjunction with other ministers of the Crown, refused to receive as representatives of the men anyone who was not in the employ of the State. Thus they were limited in the choice of their Association officials to men in the service of the State, and they could not have officials who would be able to travel to different parts of the country for organisation and other purposes. This they looked upon as a limitation of their rights of combination. The unions of the Postal service were built up on the assumption that an unlimited amount of leave—within, of course, reasonable limits—would be granted their officials, but the Department had now laid down a rule by which the amount of special leave was limited to 10 days. There were some 40,000 organised workers in the Post Office, with 50 and 60 officials, and of these officials only 15 or 20 required more than 10 days' official leave in a year in order to carry on the necessary functions of their office. They asked the Postmaster-General to extend the limit to 20 days, but he had refused, preferring to give 10 days if demanded to the whole of the employés of the Department rather than allow 20 days to those for whom the privilege was asked. This they looked upon as a blow aimed at combination amongst postal workers. It had already had disastrous effects in the Postmen's Federation by preventing the members of their executive attending the necessary meetings. They, therefore, asked the Congress to pass this resolution, and thus to express its opinion that the action of the authorities amounted to an attack on the rights of combination in the Post Office, and at the same time to assist them in getting the full and free rights which they themselves enjoyed.

Mr. Pratt (Postmen's Federation) in seconding, said his organisation was in full sympathy with the resolution. Their Federation had suffered severely through the action of the Department, because the amount of special leave now granted was not sufficient to enable their officials to carry on the work of their society, and, consequently, their interests suffered. He earnestly hoped that the Congress, by affirming the resolution, would assist postal workers to secure proper rights of combination.

As according to the rules of the Conference only two speeches were allowed on unopposed resolutions, a vote was at once taken, and the motion was unanimously agreed to.

OUR LEGAL QUERY COLUMN.

[*Questions addressed to the Editors for insertion in this column should be written on one side of the paper. Free use of fictitious names, &c., may be made. Answers are furnished by a duly qualified lawyer, but the Editors cannot undertake to be responsible for the accuracy of the views which he may express.*]

"E. H. T." writes:—"When a patent is applied for in a foreign country and refused on the grounds that the same idea has been already patented, is the patent agent legally entitled to the full amount of his fees, or should the fact that the patent was refused be taken into consideration?"

*** As "E. H. T." does not mention the name of the foreign country in which the patent was applied for it is difficult to furnish a strictly accurate answer to his question. The matter can only be dealt with in its general aspect, and in accordance with the principles of English law. If a patent agent were to consider an invention, and, after making the requisite search, were then to undertake to procure a patent, failure might furnish an excuse for the non-payment of his full charges. But it is conceived that the liability of a patent agent is not so stringent as this in an ordinary case, where he is simply retained to obtain a patent for a particular invention. He undertakes to exercise reasonable skill and care in order to test the validity of any invention which may be submitted to him, and although he ought to be able to ascertain whether an invention had been patented before, his omission to do so would not necessarily disentitle him to his fees. An attorney does not undertake to win his client's cause, nor does a doctor pledge himself to effect a complete cure; but the fees are the same in any event.

"Fuseboard" writes:—"Will you kindly inform us through the medium of your paper if there is any permission necessary for fixing a cable between the two roofs of opposite buildings, both buildings under the same tenancy, and held under lease. The buildings are opposite, one on each side of a public street."

*** The fact that the proposed wire will pass over a public street will probably make it necessary for "Fuseboard" to take certain steps before placing it in position. It is anticipated that the urban authorities in the town where "Fuseboard" carries on business have adopted the bye-laws made in pursuance of the Public Health Acts Amendment Act, 1890. Under those bye-laws notice in writing of every wire stretched above, over, along, or across any street must be given to the urban authority, signed by the owner of such wire or his agent, and containing particulars of the use or intended use of the wire, the nature and position of the several supports, and the lengths of span between the several supports. Such notice must be given within one month after the wires are stretched. Every such wire must be so stretched as not to be at any point at a less height above the street than 30 ft. where it crosses the street, and elsewhere than 18 ft., except with the consent in writing of the urban authority. The bye-laws also provide that every wire must be securely attached to adequate supports of durable material and construction, and that such supports must be situate at distances of not more than *one hundred and fifteen yards* apart, except in any case where the urban authority consent in writing to an increased length of span. Each support must be efficiently secured against forces due to wind pressure, change of direction of wires and unequal lengths of span. On reasonable notice being given by the urban authority to the owner of any wire, access at all reasonable times for the purpose of the inspection and examination of such wire or tube, and every support and other apparatus used in connection therewith, must be given or secured by such owner to the urban authority, their officers and servants.

"Fuseboard" will be well advised to ascertain whether these bye-laws are in force in his district. If not, it is anticipated that he will be amply protected if he suspend his cable securely at a sufficient height to be out of reach of the traffic in the street.

THE BRITISH ASSOCIATION, SOUTHPORT, 1903.

STREET TRAFFIC PROBLEMS.

It was perhaps unfortunate that on Thursday, September 10th, Section G did not adjourn for a short luncheon interval, and take the reading and discussion of Col. Crompton's paper on "Street Traffic Problems" when a larger audience might have been ensured, for when the author mounted the platform there were not more than a dozen listeners, pangs of hunger, or thoughts of an approaching garden party, having temporarily attracted away the majority of those who had just listened to the reading of a lengthy but most important paper on "Locomobile Design," by Mr. T. Clarkson. One by one some of the wanderers returned, having slaked their thirst or hurriedly devoured a sandwich, so that by the opening of the discussion the faithful dozen may have become doubled. The discussion was brief, indeed the only part of any real value was the remarks made by the head constable of Liverpool.

The Chairman of the section, Mr. C. Hawksley, had something to say about lamp-posts and tramway standards, which, when placed in the middle of the road, obstructed traffic. Omnibuses at present seemed to rule the speed of city traffic. Col. Crompton suggested that court yards might cost more to construct than would the widening of the streets for their whole length sufficiently to admit of a vehicle standing on each side of the road.

The Head Constable of Liverpool, after referring to the powers possessed by the police in dealing with the traffic, said that in Liverpool they had a very busy electric tram traffic, and they had definite stopping places, which meant that a crowd of people collected at these points waiting for the trams to come; they then rushed across the footways to their own danger and were also a hindrance to other traffic. That was a matter that would have to be considered some time or other, as it made a road practically a railway at certain points. He considered that the faster street traffic travelled, the safer it was. They had that experience in Liverpool. The number of accidents had considerably decreased since the introduction of the electric trams, though they had twice as many vehicles. The electric tram had educated all classes of the public to exercise greater care on the highways. They, as the police authorities, had to reconcile the claims of every class of traffic to its share of the road.

Another speaker thought that municipal authorities, before reducing fares, should widen out the thoroughfares, and make the cost of doing so a charge upon the capital of the tramways, letting the user of trams pay for it.

Col. Crompton himself was not disappointed that his paper had not been seriously contradicted in any way, because the matter was becoming a very serious and pressing one. He said that municipal authorities, after having stayed very much behind for years, rushed to obtain salvation from electric trams placed anywhere and everywhere, hoping to make them pay at any price, quite regardless of how much the public convenience suffered from them. If there had been expert authorities who could have advised on the matter, it might have prevented the highways of the country from being blocked, as they had been, by tramways, which were laid in ways where they would always be hindrances. The municipal authorities were the greatest obstructors. He had repeatedly put forward the view that there was a need not only for a central authority for the roadways,

but an equal need for a central authority for controlling the traffic in the streets. The only chance of securing rapid locomotion was to give the police more powers.

THE USE OF ALUMINIUM AS AN ELECTRICAL CONDUCTOR.

By John B. C. Kershaw, F.I.C. (London).

(Read before Section G, September 14th.)

Introduction.—The increasing use of aluminium as an Electrical conductor for bare overhead transmission lines, especially in the United States, and the claims made for this metal as a substitute for copper, led the author, in October, 1899, to commence a series of exposure tests at two localities in Lancashire, England.

These tests were made in order to ascertain the resistance to corrosion offered by *commercial aluminium rod and wire under the conditions obtaining*, with exposed bare overhead wires. Samples of aluminium rod and wire were obtained from the principal English firms, and in order to make the series of observations more complete, samples of galvanised iron wire, and of copper, and tinned copper wire, were also submitted to atmospheric influence. The methods of observation and the results obtained during the first exposure period (from October, 1899, to August, 1900), were described by the author in a paper read before the London Institution of Electrical Engineers on January 10th, 1901. This paper was reported in most of the English and Foreign Technical Journals. Reprints of the paper, and of the discussion upon it, are available for those specially interested in the subject, and will be given to any who make personal application for them.

The present paper is the record of the observations made since the date named above, and contains the chemical and physical tests of the aluminium wires exposed at Waterloo, Lancashire, together with the results obtained during two further periods of exposure namely, from August 22nd, 1900, to November 6th, 1901, and from November 9th, 1901, to December 4th, 1902.

Since it may be considered unnecessary to repeat much of the information contained in the Electrical Engineer's Paper of January, 1901, the author proposes to treat the present paper as a continuation of that of 1901, and to simply bring the tables and information of the earlier paper up to date.

I. *Production and Price.*—Table 1 of the 1901 Paper dealt with the world production and average price of aluminium in U.S.A. down to 1899. This table has been extended to the year 1902, and copies of the extended table are now in your hands. You will notice that no material alteration in the price of aluminium has occurred since 1897, although the production has materially increased. It would, therefore, appear that "bed-rock" prices have been reached by the present methods of production. A cheaper method of preparing refined alumina for the baths is required, before any further reduction in price of the metal can occur.

II. *Relative Costs of Copper and Aluminium.*—As regards the relative costs of copper and aluminium, the formula given in the 1901 paper for calculating the relative prices of equal lengths of the two metals, of equal electrical capacity, was as follows:—

$$\frac{S \times P \times c}{s \times p \times C},$$

where S, P, and C represent the specific gravity, price, and conductivity of copper, while s, p, and c represent the corresponding values for aluminium.

Table I.—World's Production, and Average Price of Aluminium, each year of the Period 1890—1901.

Year.	Production in metric tons of 2,204 lbs.†	Price per lb. in pence in U.S.A.	Remarks.*
1890	165	—	
1891	233	75	
1892	487	49	
1893	715	37	Average quality ·93 to 1·64 per cent. Si. ·32 to 1·66 per cent. Fe.
1894	1,240	30	
1895	1,418	27½	
1896	1,789	20	
1897	3,394	17½	
1898	4,033	16⅓	Average quality ·02 to ·13 per cent. Si. ·12 to ·32 per cent. Fe.
1899	6,807	16½	
1900	7,743	16	
1901	7,240	15½	
1902	8,000	—	

† From the "Mineral Industry Annual," Vols. viii. to xi.
* From *Comptes Rendus*, 1898. Moissan's Tests.

Table II.—Results of Exposure Tests on Aluminium and other Wires at Waterloo, Liverpool.

Composition and form of sample.	First exposure. Oct. 13, 1899, to Aug. 16, 1900. Changes § in weight.	Remarks.	2nd exposure. Aug. 22, 1900, to Nov. 6, 1901. Changes § in weight.	Remarks.	3rd exposure. Nov. 9, 1901, to Dec. 4, 1902. Changes § in weight.	Remarks.
Aluminium rod ⅜ in. diameter	Nil.	These five samples were all pitted, especially on the undersides were water drops had collected and dried.	+ ·11%	Badly pitted and corroded, especially on undersides of rods.	+ ·03%	Badly pitted and corroded, especially on undersides of rods.
„ ¼ in. „	+ ·13%		+ ·18%		+ ·025%	
Aluminium wire, No. 1 sample	+ ·41%		This sample was withdrawn for physical and chemical tests, August, 1900.			
„ No. 2 „	Nil.		× ·50%	Badly pitted and corroded, especially on undersides of wires.	This sample was withdrawn for physical and chemical tests Nov. 1901.	
„ No. 3 „	+ ·55%		Nil.		+ ·33%	Badly pitted and corroded, especially on undersides of wires.
„ No. 4 „	—	—	—	——	+ ·87%	
Galvanised iron wire, No. 1 sample	− ·15%	No change in appearance to the eye.	− ·46%	No change in appearance to the eye.	− ·54%	No change in appearance to the eye.
Galvanised iron wire, No. 2 sample	− ·16%		− ·80%		− 1·10%	
Copper wire No. 1 sample...	Nil.	Oxidised on surface but not pitted or corroded.	Nil.	Tinned copper wire no longer distinguishable from untinned wire—both coated with fine black deposit of CuO.	− ·10%	Wires indistinguishable, both quite black.
Tinned copper wire No. 1 sample	Nil.		Nil.		− ·06%	

§ + equals gain, − equals loss.

Table III.—Chemical and Physical Tests of the Aluminium Wires Used for the Exposure Tests at Waterloo, Liverpool.

No. of sample of aluminium wire.	Where obtained, and date.	Diameter in inches.	Chemical tests. Per cent. Fe.	Chemical tests. Per cent. Si.	Physical tests. Relative conductivity, copper 100.	Physical tests. Tensile strength, tons per sq. in.	Physical tests. Breaking load in kgs. Before exposure.	Physical tests. Breaking load in kgs. After exposure.	Physical tests. Linear resistance—Microhms per metre at 15° C. Before exposure.	Physical tests. Linear resistance—Microhms per metre at 15° C. After exposure.
No. 1....	British Aluminium Co. 1899	·129	2·00	1·06	51·3	?	?	157·50	?	?
No. 2....	British Aluminium Co. 1899	·130	Qualitative tests only —Si. Fe. Na. traces of Mn. and C.		54·0 52·1	11·93 11·86	160·5	155·25	3,870	4,330
No. 3....	T. Bolton & Co., 1899	·112	·59 ·55	·57	56·0	13·97 14·47	142·25	141·0	4,745	4,900
No. 4....	Callipe & Dettmar, 1901	·126	·41 ·40	·112 ·146	57·6	11·72 11·47	147·0	147·5	3,700	3,760

Notes—1. Owing to the corrosion, no "Relative Conductivity" tests after exposure were reliable.
2. Chemical tests of Nos. 1, 3 and 4, by J. B. C. Kershaw, of No. 2 by the National Physical Laboratory Chemists.
3. Physical Tests of Nos. 2, 3 and 4 by National Physical Laboratory officials.

Inserting the latest figures* for these values in the formula given above we have—

$$\frac{8{\cdot}93 \times 66 \times 59}{2{\cdot}68 \times 159 \times 100} = \frac{34{,}773}{42{,}612} = \frac{816}{1{,}000}$$

as the price ratio of the two metals when used for electrical purposes, and copper is seen to be the less costly metal. The price of electrolytic copper has, however, undergone such striking variations during the last twelve months that this ground of superiority over aluminium may be lost before this paper is read.

III. *Installations of Aluminium for Conducting Purposes.*—With reference to installations of aluminium for conducting purposes in place of copper, the following must be added to the list of bare transmission lines given in the earlier paper:—

1. Niagara Falls and Buffalo, U.S.A., 15,000 H.P. transmitted 22 miles. Three aluminium cables; three-phase transmission at 22,000 volts. Each cable made up of 37 strands of aluminium wire.

2. Snoqualmie Falls and Seattle, California. 12,000 H.P. transmitted 32 miles at 30,000 volts. New aluminium transmission line.

3. Sarno, Pompeii and Forre Annunziate, Italy. Transmission of 450 H.P. 12 miles at 3,600 volts.

4. Lewiston and Auburn Electric Co., U.S.A. 21 miles.

5. Boston and Maine Railroad, U.S.A. 20 miles.

6. Boston Electric Lighting Co., U.S.A. 100,000 lbs.

7. Shawinigan Falls and Montreal, Canada (under construction). Transmission of power 84 miles at 50,000 volts. It is stated that 250,000 lbs. of Aluminium will be required for this line, which is to be made up of seven strands of No. 6 wire.

8. Massachusetts Electric Co. 500,000 lbs.

9. Old Colony Street Railway Co., Ms. 10 miles.

The author has heard of only one installation of bare aluminium conductors for power transmission in the United Kingdom or in Germany, outside of the works manufacturing the metal.

IV. *Durability Tests of Aluminium and other Metals under Atmospheric Exposure.*—As regards the durability tests of aluminium and other wires, commenced in October, 1899, the following details from the original paper are given in order to enable those present to understand the methods of observation employed.

"The rods and wire were cut into 2-ft. lengths, and were mounted upon glass insulators in two frames, so that their position was parallel one to the other, and all were horizontal with regard to the ground.

"Fig. 1 is a photograph of one of those frames containing the sample wires. The frames carrying the wires were so placed that the drops of water collecting upon the wires in wet weather could not by any chance pass from one wire to another, and thus bring electrolytic action into play. Each length of wire was carefully marked, and weighed before commencing the exposure, and the weights recorded. The one frame with its nine insulated sample wires was exposed upon the roof of a building in St. Helens, Lancashire, from October 11th, 1899, to August 23rd, 1900; and the second frame was similarly exposed at Waterloo, Lancashire, for the same period of 10 months.

The climate of St. Helens is probably too well known to need description; but it has improved considerably in recent years owing to the closing of several chemical works. The place in which the wires were exposed is now singularly free from chlorine and hydrochloric acid gases.

Waterloo is on the Mersey, six miles north of Liverpool, and its atmosphere is that of an ordinary west-country seaside town, *plus* much sand. During the exposure period of 10 months the frames were not touched or moved. At the end of this period the wires were removed from the frames, cleaned from the soot and dirt of all kinds which had accumulated upon them, and after thoroughly air-drying, were re-weighed.

The second set of wires which were exposed at St. Helens, were unfortunately destroyed in 1901 during repairs to the roof upon which they were placed, and consequently the exposure tests have only been continued at Waterloo.

Tables II. and III. contain the results obtained with the Waterloo set of wires and rods, during the three exposure periods extending from October, 1899, to December 4th, 1902, and the facts and figures given in these two tables deserve careful consideration.

Summarising the results recorded in Table II., we may say that all the samples of aluminium gained in weight during exposure, and that *all* were pitted and corroded, especially on the under side where the water drops had collected and dried. The rods appeared to have suffered rather less than the wires, and it is therefore probable that in the course of drawing down into wire the aluminium undergoes physical change.

The sample of aluminium wire marked 4, though purer than the other samples, was nevertheless badly corroded at the end of one year's exposure. The samples of this wire, after one year's exposure, and of the two aluminium rods after three years' exposure, are here for your inspection and comment.

The galvanised iron wires though unchanged in appearance to the eye, gradually lost in weight—this loss being a progressive one, and greatest in the third year. The two samples, after three year's exposure at Waterloo, are here for your inspection.

The copper and tinned-copper wires, judging by the weight method of testing, stood exposure best, but the latter wire had lost nearly the whole of its tin covering by the end of the second year; and the wires, as you will see, are now indistinguishable.

Table III. contains the results of the chemical and physical tests made with the aluminium wires, Nos. 1 to 4. The most striking feature of these results is, the high percentage of impurity, and the low relative conductivity of the samples of aluminium, sold for conducting purposes in the United Kingdom in the year 1899, and the slight deterioration both in breaking load and in conductivity during exposure. No. 1 wire was evidently alloyed with iron to increase its tensile strength; but the 1 per cent. of silicon was an unnecessary and harmful impurity. The low relative conductivity of 51 for this wire, is only what one would expect with a sample, containing over 3 per cent. of silicon and iron.

It may be urged that had samples of the purest aluminium containing only traces of iron and silicon been submitted to exposure the results would have been materially better. The object of the investigation was, however, to test the durability of commercial aluminium; and the sample of wire obtained in London in 1901, though containing only ·55 per cent. of silicon and iron, has not undergone one year's exposure at Waterloo without extensive and deep corrosion.

V. *Conclusions.*—The author does not wish to base any unfair conclusions upon the result obtained in these exposure tests. He may, however, claim to have proved that some of the aluminium rod and wire which was being manufactured and sold in England for electrical purposes in the years 1899 and 1901 was notable to stand atmospheric exposure on the coast of Lancashire without corrosion. It is only a fair deduction from these exposure tests to assert, that aluminium manufacturers have yet to prove the metal to be a satisfactory and durable substitute for copper in bare overhead transmission lines, or for electrical *work which involves exposure to climates near the coast.*

The author's thanks are due to Dr. Glazebrook, of the National Physical Laboratory, London, for assistance received in the course of this investigation.

* Prices of the metals in rod form, July 31st, 1903:—
Copper, £66 per ton.
Aluminium, £159 per ton.

Discussion.

Mr. B. Hopkinson, speaking of the use of aluminium wire for tramway purposes, said he had had some experience in using aluminium on the Leeds city tramways, but it had had to be discarded. It was found necessary to use a special section of wire and to grip the wire with mechanical ears. That was overcome, and so was the difficulty in joining the lengths together; but they found, when in actual use, a serious difficulty arose because of the high coefficient of expansion of aluminium. They found in hot weather, that the wire sagged down to a serious extent; far more than was desirable on a tramway. Then the officials had to take it up to reduce the sag, but when cold weather came the aluminium drew itself out, and when the hot weather came again it sagged again. The next difficulty they found was that the aluminium wire was worn by the trolley wheel which rubbed away the protective coat of oxide; but the principal difficulty was that connected with the expansion of the wire.

The Chairman: Were any attempts made to neutralise the effects of the expansion by putting in a correcting length?

Mr. Hopkinson: No, the wire could stretch beyond its limit.

The Chairman: With regard to the weight of snow—did they deal with that?

Mr. Hopkinson: As far as his experience went, they never had any trouble at all with snow on the trolley wires.

The Chairman: The snow that came during the night would not be shaken off.

Mr. Hopkinson: The thickness of snow required to make a serious difficulty was very large. They had not found that to be of any importance at all.

THE ELECTRICAL CONDUCTIVITY OF CERTAIN ALUMINIUM ALLOYS AS AFFECTED BY EXPOSURE TO LONDON ATMOSPHERE.

By Ernest Wilson, Professor of Electrical Engineering, King's College, London.

(*Read before Section G, September 14th.*)

The physical properties of certain light aluminium alloys have formed the subject of previous communications,* and, as stated therein, a specimen of each alloy was placed on the roof of King's College, London, in order to investigate the effect of exposure to London atmosphere. The specimens are in the form of wire 0·126 in. (3·2 mm.) diameter, and were placed on the roof on June 11th, 1901. They were taken down and tested on July 23rd, 1902. This paper gives the results of another year's exposure. It was shown that during the first year's exposure the series of copper-aluminium alloys (Nos. 16, 4, 13, 14, 15) diminished conductivity to a greater extent the greater the percentage of copper. It will be seen from the subjoined table that this process has progressed still further, but that the variation during 1902-3, expressed as a percentage of the value found in 1902, is smaller than the corresponding quantity in 1901-2. In the 1902 communication it was shown that alloys Nos. 21, 22 had not diminished conductivity by exposure. They have now done so. On the other hand, alloy No. 23 has not changed during 1902-3, whereas it diminished conductivity 2·34 per cent. during 1901-2. The Mn series (Nos. 9, 10, 23) have changed very little, and No. 23 has a comparatively high breaking load of 35,300 lbs. per sq. in. The Ni series (Nos. 7, 8, 20) have also changed very little during 1902-3. For exposed light

* See *Journal Institution of Electrical Engineers*, 1902, Part 154, Vol. XXXI.; also British Association Reports, 1901-1902; also *Journal of Society of Arts*, December 13th, 1901.

aluminium alloys the results confirm the conclusion previously arrived at—namely, that copper alone should not be used in comparatively large quantity.

No. of specimen.	Analysis.						Specific resistance in 10^{-6} ohm at 15° C. before exposure in 1901.	Percentage variation of elec. resistance at 15° C.			Breaking load in lbs. per sq. in. of cross-section.
	Si.	Fe.	Cu.	Ni.	Mn.	Zn.		During 1901-2, taken on value in 1901.	During 1902-3, taken on value in 1902.	During 1901-3, taken on value in 1901.	
16	0·31	0·37	0·11	—	—	—	2·92	1·04	0·65	1·69	26,600
4	0·38	0·25	0·16	—	—	—	2·88	1·86	1·10	2·98	25,700
13	0·38	0·25	1·58	—	—	—	3·34	3·49	1·79	5·33	39,000
14	0·40	0·31	1·86	—	—	—	3·25	5·24	1·52	6·84	40,600
15	0·40	0·40	2·61	—	—	—	3·34	7·20	2·77	10·15	43,500
1	0·38	0·22	0·17	—	—	0·62	2·86	3·54	1·05	4·62	28,100
2	0·43	0·28	0·30	—	—	1·20	2·94	2·67	3·09	5·84	30,500
5	0·43	0·39	0·09	—	—	2·04	3·07	2·33	1·14	3·50	26,000
7	0·37	0·25	0·05	0·75	—	—	3·05	1·22	0·73	1·96	29,700
8	0·35	0·29	0·09	1·19	—	—	3·24	2·10	0·11	2·22	33,700
20	0·37	1·10	0·06	2·25	—	—	3·18	1·55	0·23	1·78	38,600
24	0·35	1·16	0·09	—	—	—	2·97	0·765	0·76	1·53	31,300
3	0·37	0·28	0·59	—	—	0·59	3·06	2·52	0·82	3·36	30,500
6	0·39	0·31	0·63	—	—	1·20	3·12	2·02	0·12	2·14	30,900
17	0·35	0·53	0·10	0·83	—	0·90	3·03	0·63	0·50	1·13	31,700
12	0·31	0·59	0·19	1·09	—	0·73	3·33	1·26	1·02	2·24	31,700
18	0·43	0·40	0·21	1·13	—	1·94	3·24	2·29	1·07	3·38	34,500
19	0·35	0·29	0·11	2·01	—	1·77	3·26	2·60	0·81	3·43	36,200
11	0·39	0·56	0·24	2·31	—	0·38	3·48	1·95	0·425	2·38	34,500
22	0·37	0·43	1·08	1·29	—	—	3·41	−1·42	3·96	2·48	45,900
21	0·39	2·57	0·10	1·39	—	—	3·24	−0·97	3·28	2·27	42,200
10	0·32	0·54	0·02	—	0·05	—	3·09	0·783	0·31	1·09	29,200
9	0·31	0·35	0·03	—	0·35	—	3·30	1·94	−0·55	1·39	30,500
23	0·44	0·56	0·09	—	1·78	—	3·49	2·34	0·00	2·34	35,300
A1.*	0·14	0·31	—	—	—	—	2·76	not exposed.	2·70	—	28,200

* Commercial aluminium.

Discussion.

Mr. Wilson said that the particulars given in Mr. Kershaw's paper referred to aluminium which was exposed near the sea, and he thought the tables given did not show that aluminium was seriously at fault. In Table III., No. 4, the increase of electrical resistance during the three years worked out at 1·6 per cent. Before exposure, it took 147 kgs. to break the wire and after exposure, 147·5. That was the actual load. He (Mr. Wilson) argued that that was a stronger wire after the test than it was before, and its electrical resistance had gone up only 1·6 per cent. He thought that was a very good wire. Mr. Kershaw had given the variation in the value of the weight; it would have greatly assisted them if he had given the variation in the electrical resistance. Comparing one thing with another, he thought there was nothing seriously wrong with the aluminium wire given. The conditions of aluminium were being improved nearly every day, and the metal was being got more pure. There was a very large amount of aluminium installed in the United States, and he heard the other day, that a quotation had been asked for, for a very large quantity for an overhead line in the United Kingdom.

Mr. J. B. C. Kershaw said that the sample of aluminium marked "4" in Table III, was only exposed one year, not three years; but if they would look at the previous samples, they would find that the percentage had increased 7 or 8 per cent. After exposure for three years No. 2 had gone up to 4,330 microhms per metre, and wire No. 3 had gone up to 4,900. There was a considerable increase. Those were the two wires which had been up three years. With wire No. 4 the increase would have gone on slowly, because it was a better wire. He had no doubt that some of the deterioration of the wire at Waterloo was due to the atmosphere, and, therefore, he argued that aluminium wire near the sea coast would be rather dangerous, and he could not advise electric power companies to adopt it yet.

A Member remarked that it occurred to him, on looking at Mr. Kershaw's figures, to ask whether the sand had any effect on the wires?

Mr. Kershaw: No; they were in a sheltered spot. He did not think the sand would carry salt.

Mr. Wilson: The variation in No. 3 was 3·28 per cent. in three years; but his inference from that was that the metal was not pure.

Mr. Kershaw: It was commercial metal. In Table III. it was clearly stated.

THE REVERSIBILITY OF THERMODYNAMICS.

By J. Swinburne.

(*Read before Section A, September 11th.*)

A new way of looking at an old subject can do no harm, and may do, and generally does, a great deal of good. In this paper it is submitted that the ordinary discussion of the science of thermodynamics makes the subject unnecessarily obscure, and leads to all sorts of errors; and its object is to propose a different treatment which, it is hoped, would make the science more easily understood.

There is no branch of physical science so commonly misunderstood, not only by students, but also by scientific men of considerable standing, as thermodynamics. Some time ago I asked an eminent authority on the Continent to join in a discussion on entropy which had arisen out of a note to the presidential address I had the honour of delivering before the Institution of Electrical Engineers last year. He replied that though I was quite right in my statement that most writers on physics had got hold of a wrong idea of entropy, the matter was merely pedagogic, and therefore he would not discuss it in print. A question of pedagogy would be outside the province of a mere engineer; but as it is not really a question of method of teaching young men at colleges, but of giving clear ideas to scientific men who are not specialists in thermodynamics, the subject is of real scientific importance; and I willingly acceded to the request of the committee to open this discussion; and with the view of facilitating matters, I have written out this paper for circulation beforehand.

Present or Orthodox Treatment.

The study of thermodynamics suffers from the historical development of the science. During the first half of last century the principle of the conservation of energy was on its trial, and, though he soon discovered his mistake, Carnot had supposed that in his cycle as much heat came out of the working substance as went in. I pretend to no knowledge of the history of thermo-dynamics, but it looks as if Clausius, realising that the heat is not conservative in a Carnot cycle, found a function, S, which is. Then came the question of the second law and the best way of formulating it, and the whole discussion centred round the Carnot cycle with dQ/T a complete differential. Instead of S, Q and T I will use ϕ, H and θ in this paper, as Q is generally used in other branches of physics for the quantity factor of energy, not for energy, and T for kinetic energy; and if ϕ is used for entropy, θ may well be used for temperature, as by Rankine, Maxwell and others.

The first matter generally is to state the law of the conservation of energy and to define "heat." Here there is a complete failure. The definitions and explanations really come down to saying in a more or less roundabout and complicated way that heat is what makes things hot. In its way this would be quite a nice and all-sufficing definition, but it is not adhered to at all. The domination of a name comes in. The increase of internal energy necessary to produce a change of (physical) state, such as melting ice, was called heat before thermodynamics began. Objectors to the caloric theory, I think, refused to call this energy heat, in order to annoy their opponents; but when the caloric advocates disappeared by dying out, or perhaps by being occasionally convinced, increase of internal energy became latent heat again; and then the increase of internal energy and the external work together became latent heat, having a symbol C_p or K_p to itself, so that increase of U where there is no chemical change is heat, and the external work done per degree rise of temperature is part of the latent heat of the body, so the definition goes by the board, and heat that makes things hot is called "sensible," perhaps as a stigma on the other kinds of heat. The definition of heat is thus wanting; I will quote from some correspondence I had with one of our leading mathematical authorities on thermodynamics. "What is wanted is a definition of *heat*. Can you define *heat*? If you can give a definition which will make it perfectly *clear what is heat and what is not heat*, you will be doing good work. But you must cover all possible cases." The italics are his. Now what does my correspondent want? There are two classes of definition in science. One is a mere verbal distinction which fits pre-existing ideas and conveys no information. For instance, everyone in the room has, no doubt, a perfectly clear idea of what energy is, and also knows what is energy and what is not, in any given case; but to define energy so as to convey any information to anybody who has no pre-existing notion of it is no easy task. But perhaps what he really meant was something like this. "Is latent heat, heat? Surely external work is not heat. Is chemical energy heat? How far is radiation, thermal or luminous, heat? Are electron flights ever heat? If so, when are they kinetic energy and when heat? How far and under what conditions are electro-magnetic waves heat? Is the energy of pedesis heat? If so, and the little particles are made to jolt bigger particles, and so on till they finally shake lumps, is that heat or directed kinetic energy, and where is the line of demarcation? At what stages in the electrostatic or electro-magnetic hysteresis cycles does the entropy increase?" I do not know whether a definition which would answer these questions would satisfy my friend, but some such definition is wanted. Many of these questions are no doubt answered by inference in papers on those particular subjects written from a thermodynamical standpoint; but an ordinary treatise on thermodynamics does not touch them, or answer my friend's question in the least.

Then there is a difficulty about thermometry. The Fahrenheit scale takes the expansion of mercury one-hundredth per cent. as a "degree," the Centigrade divides the difference of two arbitrary temperatures into 100 parts, and is therefore regarded as more scientific, and the Reaumer exists in real life but not in science. Much trouble is therefore devoted to elucidating Kelvin's scale, and it is then generally assumed that the Fahrenheit and Centigrade thermometers read in the Kelvin scale, only with different zeros and different units of temperature. The main point to which attention is specially directed, however, is, that writers are so eager about showing that production of work means disappearance of heat, and so anxious to explain Kelvin's scale and to discuss the second law and Carnot's cycle, that they discuss the whole subject only in connection with ideal reversible changes. Then the fact of dH/θ being a complete differential in reversible changes is very attractive to many people, because they can then get a lot of undeserved happiness in stringing together partial differential equations tracing the relations of every conceivable thermodynamic quantity with every other, down to the most remote cousinships. Thermodynamics is thus apt to degenerate into nothing better than an exercise in differential equations.

In discussing the principle of entropy, the entropy of the working substance is treated almost exclusively, and that in connection with reversible changes and cycles alone. Irreversible changes are dis-

cussed as a sort of curious exception, but only very slightly. In many cases two bodies are considered before and after equalising their temperatures, and their increase of total entropy is discussed, but there is no explanation of how the entropy increases; only the initial and final stages are considered.

But the chief ground of the accusation I have the honour to bring is that anxiety to discuss the Carnot cycle and its bearing on the second law, and to work with a quantity ϕ which could be assumed conservative, has led to a very high mathematical development of the theory of reversible changes, and has relegated real thermodynamics to an undeserved background.

My historical notions may be wrong, but it looks as if Clausius, when Carnot's reasoning had apparently been vitiated by his original mistake as to conservation of heat, looked for something that was conservative in the Carnot cycle and found entropy. He got the "tropie" from the Greek, and put on the "en" to make the word sound something like its conservative analogue "energie." Then in discussing real changes he found that entropy is not conservative, and founded the principle of modern thermodynamics, that the entropy of the universe strives to increase; a principle which is the very back-bone of the science. In spite of this, the ordinary treatise, though it mentions Clausius's principle, and perhaps touches on Kelvin's work of the same period, says very little about it.

Entropy is defined with reference to reversible changes only by the equations

$$\int d\text{H}/\theta = \phi \text{ and } (\int) d\text{H}/\theta = 0,$$

which give no sort of notion of what entropy is, and which are only numerically correct in the case of reversible changes and cycles respectively, and, in fact, are never even numerically true. The foundation of thermodynamics is that neither of these equations is true. I know of no writer who has tried to give any sort of explanation of what is meant by entropy, except that it is the quantity factor of heat, which is obviously nonsense. It is not meant that specialists on thermodynamics do not understand their own subject or write inaccurately; my complaint is that the treatment of thermodynamics is obscure and misleading, and has led to great confusion and much error.

Nearly all writers on physics, for instance, define entropy by the equation $d\text{H}/\theta = d\phi$, or its equivalent. That is to say, they are led to suppose that what would be true if there were any reversible changes is true in fact. $d\text{H}/\theta$, or $d\phi$, is treated as a typical complete differential. An adiabatic change is supposed to be isentropic. $(\int) d\text{H}/\theta = 0$ is supposed to be the second law of thermodynamics. Entropy is said to be a factor of heat, and so on, a whole tissue of errors and misconceptions thus arising from the impression given by looseness of diction. When any man of ordinary intelligence and the necessary training cannot understand what has been written, it may be taken for granted it is the fault of the writer. Generally, people are of an opposite opinion, perhaps thoughtlessly, and if the treatment of a subject proves to be puzzling, the author is rather to be admired for being master of such a difficult subject, and not blamed for not making it simple; whereas, if he put the matter simply and clearly, he would get but little credit for his work. This is especially true of subjects that can be treated mathematically; the scientific world has an immense reverence for anything put in mathematical language, though it needs much more ability and a clearer head to put it in words. Was it not Maxwell who said that mathematics is a shorthand, and that anything that can be put in symbols can be put in words, if the writer really understands it? Nobody really understands unless he can express himself in words. Thermodynamics seems to be peculiarly unfortunate in being a vehicle for blind mathematics. It is not for a moment hinted that science cannot be clear if it is mathematical; quite the reverse. The great writers on physics use mathematics in such a way that they are merely shorthand methods of explaining physical ideas. Any reader grasps the physical ideas at once, unless his mathematical equipment is too limited; but even then he feels the physical ideas are there, and very often finds the study a good way of learning mathematics. On the other hand, another writer will make the simplest matter unintelligible by mathematical treatment. Thus such an expression as $\int d\text{H}/\theta = \phi$ is a perfectly clear statement of fiction. But when we come to fact we are told that $\int d\text{H}/\theta < \phi$. Now what does that mean? Being an engineer, in coming across such an expression I sought an interpretation that gave a physical meaning. θ could not be the temperature of the reservoir, because there may be no reservoir; for instance, the body ceding heat may not be at uniform temperature, for example, in considering part of a conductor of heat where there is a temperature gradient. Then θ cannot generally be the temperature of the body because that is not usually uniform. To make sense, θ is the temperature of the bounding surface, and H is a flux through the surface. But I find I am peculiar in this interpretation. What then does the orthodox writer mean by H and θ in irreversible changes, and what idea is really in the mind of the reader as he glides over such expressions? That there is a tendency towards blind mathematics and fogginess of idea in thermodynamics is, I submit, proved by the inaccuracy of the terms used, the absence of named units, and the absence of physical ideas. How many chemists have any clear cut idea of what the "Thermodynamic Potentials" really are?

The entropy principle was formulated half a century ago. Before and since then the question of what determines the direction of chemical action was eagerly discussed. The entropy principle was supposed to be familiar to every scientific man, but it was not assimilated in the least. After about 20 years the chemical puzzle was solved by Horstmann, who pointed out that the increase of entropy is the criterion. Rayleigh, doubtless independently, said the same in 1875; then followed Gibbs, Massieu, and Helmholtz,* Rayleigh said it in plain English; the others, especially Massieu, said it in mathematics. But even that has produced but little effect, and now, after more than half a century, the principle of increase of entropy is by no means generally understood by chemists, nor by engineers, though they are both exceedingly anxious to understand and use thermodynamics. This might be the fault of chemists, engineers, and other scientific men, but it seems much more likely to be due to obscurities in thermodynamics.

It is easy to get the reputation of a reformer by finding fault with existing conditions. But the object of this paper is not that, but to lay before this section, in which the leaders in thermodynamics are particularly thick, a sort of scheme or syllabus of the subject for severe, but, I hope, kind criticism. The simplest course is to sketch out a sort of programme. To work it out would be to write a treatise on thermodynamics — a most serious undertaking. I have, however, attempted a short elementary exposition, especially as far as it concerns mechanical, apart from chemical, engineers. This is now appearing in *Engineering*.* In this is exemplified a treatment of elementary thermodynamics, which depends largely on the reversal of the ordinary method. For instance, dissipation and waste are explained before reversibility and the Carnot cycle; entropy is defined without any reference at first to heat passed into a body; the increase of entropy is treated as normal, and reversible changes as a purely ideal exception; the second law of thermodynamics is merged in the impossibility of perpetual motion; the entropy of the universe and of the isolated system is treated before that of the working substance; and the growth of entropy during conduction is treated later. For that reason this paper is headed as it is. To put the matter succinctly, for ease in discussion, a sort of sketch will now be set out.

Skeleton of Thermodynamics.

Energy can be divided broadly and clearly into two kinds, which may be called work and heat. Different kinds of work can be converted one into another wholly in idea, and nearly wholly in fact; different kinds of heat can be converted wholly into one another. Work can be wholly converted into heat, but heat can only be partially converted into work if the converting substance returns to its original state, the rest of the heat being degraded into a less available form. This definition of heat includes the heat that makes things hot, and locomotive heat in general, and it also includes "latent heat" at constant volume, but only part of any mis-named "latent heat" that includes any form of external work. It includes latent heat of fusion, of vaporisation apart from external work, and of allotropic modification. What is most heterodox is that it includes chemical energy.

There are three classes of perpetual motion. They are all impossible, and two of them are absurd, but third-class perpetual motion is approximately possible.

First-class perpetual motion is when an otherwise isolated system can give out energy continually, or without decreasing its own. The impossibility of first-class perpetual motion, coupled with the impossibility of an energy sink is the principle of the conservation of energy, and the first law of thermodynamics.

Second-class perpetual motion is when an isolated system, in spite of friction or its equivalent, goes on continually. Second-class perpetual motion would not contradict the principle of the conservation of energy. Its impossibility is the second law of thermodynamics.

Third-class perpetual motion is when an isolated system—a mechanism, for instance—has no friction, or no equivalent of it, and therefore goes on or changes continually. The impossibility of third-class perpetual motion is the third law of thermodynamics. It is not called the third law, but it deserves that rank.

Waste.

Work is valuable to man, and the portion of any heat that can be converted into work, leaving the converting substance in its original state, is valuable; but the rest of the heat is waste. When work is degraded into heat, a portion of it is available as work, the rest is waste. The third law of thermodynamics states, in other words, that no change in nature takes place without incurring waste.

Definition of Entropy.

The increase of entropy of an isolated system, multiplied by the lowest available temperature, is the incurred waste. The waste, therefore, depends on the lowest available temperature and the entropy. As any given change can only increase the lowest available temperature infinitesimally, the second and third laws may be stated in the form, "The entropy of the universe strives to increase." So does the waste. Its maximum will be reached when all heat is unavailable and there is no work left. The incurred waste increases faster than the entropy of the universe, because the lowest available temperature is always rising. The limiting expression "incurred" is used before waste, advisedly. Suppose, in an isolated system, some gas expands doing some work external to the gas. The heat of the isolated system is diminished, the work increased, and the total energy unchanged. The heat being diminished without any corresponding rejection at lower temperature, the waste portion is decreased. There is thus actual decrease of waste. But, to get the gas back to its original state, work must be degraded into heat again, and, according to the third law, there is then increase of waste. Had the process been reversible, there would have been no increase of incurred waste in the system, but, as far as the gas alone is concerned, its own increase of entropy multiplied by the lowest available temperature would be the waste involved in bringing it back to its original state.

* The order may be corrected if necessary when there is an opportunity of reference to books.

* "Entropy, or Thermodynamics from an Engineer's Standpoint."—*Engineering*, August 28th and following issues.

When during a change the entropy of a body forming part of the system diminishes, the entropy of another part must increase to the same extent in an ideal change, and to a greater extent in a real change. In the ideal change the increase of entropy of the body is called compensated, in a real change the part of the increase equal to the corresponding decrease elsewhere is compensated entropy, ϕ_c, and the balance is uncompensated entropy, ϕ_u, where $\phi_u = \phi - \int d\text{H}/\theta$.

When the heat of one body diminishes as that of another in contact with it increases, it is usual to say that the heat moves from one to another. Similarly, when the entropy of one body diminishes while that of another in contact increases to the same or a greater extent, it is convenient to say the entropy moves and grows also. From the idea of the entropy of an isolated system and its increase in every change, it is easy to pass to the idea of the increase or decrease of the entropy of a body. In the case of reversibility the entropy of the isolated system is conservative, so that the discussion of the behaviour of any body or bodies may be treated as in dynamics, by examining the changes and interrelations of the external co-ordinates; and the conservation of entropy, in the ideal case of reversibility, is a very convenient assumption, especially as it specially helps the treatment as in dynamics, the conservation of entropy corresponding with the conservation of energy. The exaggeration of the importance of this treatment has done much to foster incomplete understanding of thermodynamics.

By treating the increase of entropy of an isolated system as the fundamental idea and variations of the entropies of the parts as derived ideas it is submitted that a much clearer notion is obtained. It is more convenient in practice, however, to consider the entropy of some substances or volumes which form parts of isolated systems. In this connection we have the following propositions:—

Reversibility.

A reversible change is an ideal change which could take place with everything involved in the other direction.

When a reversible change takes place in an isolated system there is no increase of incurred waste, for if there were, on reversing there would be decrease of incurred waste, and second-class perpetual motion would be possible.

When a reversible change takes place, therefore, the entropy of the isolated system remains constant.

A reversible cycle is a series of reversible changes which brings the working substance back to its original condition. The entropy of an isolated system is not altered by a reversible cycle being performed inside it.

In any reversible change, the total entropy of the system being constant, the increase of entropy of any part is compensated by an equal decrease of another part. The decrease of entropy of any body can only take place by a process which involves at least equal increase of entropy of the rest of an isolated system. Thus the entropy of a body may be reduced without its giving out heat by a thermo-electric circuit, but that involves at least equal increase of entropy elsewhere in the electric circuit. Except in the case of a thermo-electric circuit, the entropy of a body can only be reduced by its giving out heat, for if it could be reduced by giving out work, there would be no corresponding increase outside, and second-class perpetual motion would be possible.

The reversible increase of entropy of a body can only take place by its taking in heat from outside (except by a thermo circuit), otherwise the entropy of an isolated system would be increased, and the change would not be reversible.

The entropy of a body, compared with its entropy in a standard state, is the entropy that must at least come out of it in bringing it back to its standard state; or it is a quantity which, when multiplied by the lowest available temperature, gives the waste portion of the heat given out in bringing the body to its standard state by reversible changes.

As the waste portion, or loss L, of heat given out through the envelope, H, is $\text{H}\theta_2/\theta_1$ where θ_1 is the temperature of the envelope, and θ_2 the lowest available temperature; and as by definition $\theta_2\phi = \text{L}$, $\phi = \text{H}/\theta_1$, or if the temperature of the envelope varies during the output of the heat H, $\phi = \int d\text{H}/\theta$. Thus the entropy of a body in state B compared with state A is $\phi_\text{B} - \phi_\text{A} = \int d\text{H}/\theta$ where H is the heat that would be given out or taken in if the change were reversible. The third law shows that in fact $\phi_\text{B} - \phi_\text{A} > \int d\text{H}/\theta_1$ the excess being the uncompensated entropy ϕ_u.

The entropy of a body thus depends on its state, and not on its past history.

Equilibrium.

If any small change imagined in an isolated system involves decrease of entropy, that change is impossible, in accordance with the second law. If it causes no change of entropy, there is equilibrium as far as that change is concerned, and no change will take place in either direction. If the change would increase the entropy, the change is possible and may take place, but only in that direction.

A possible change thus involves increase of entropy, or uncompensated entropy.

The uncompensated entropy of the working substances can be expressed in terms of the co-ordinates of each working substance alone, without other reference to the rest of the isolated system. Thus in the case of a working substance, where ϕ_u is the uncompensated entropy, H the heat taken in, θ the temperature of the envelope, U the heat of the body, according to the definition given above, and W the external work done.

$$d\phi_u = d\phi - d\text{H}/\theta \text{ and } d\text{H} = d\text{U} + d\text{W}.$$

therefore

$$d\phi_u = d\phi - d\text{U}/\theta - d\text{W}/\theta,$$

and if there is equilibrium,

$$d\phi - d\text{U}/\theta - d\text{W}/\theta = 0.$$

If there is uncompensated entropy on making the change

$$d\phi - d\text{U}/\theta - d\text{W}/\theta > 0.$$

The integral of this quantity is therefore written with the sign reversed and disguised under the name of a "Thermodynamic Potential," so that increase of uncompensated entropy decreases instead of increasing the quantity. Uncompensated entropy is a drawback, and thermodynamic potential is an advantage. It is with great respect to Prof. Planck or Prof. van Laar* that it is submitted that thermodynamic potential is a bad name for the function

$$\text{U}/\theta + \text{W}/\theta - \phi.$$

The third law shows that heat can never be changed into work to the extent it would be by a reversible cycle. The work that would be gained by a reversible cycle, and is not gained in a real change, may be called the "ungained work." Prof. Duhem† calls it the "uncompensated work." With respect to such a leading authority, it is submitted the term is misleading. Increase of entropy is a drawback, unless there is corresponding decrease elsewhere, so Clausius's term, uncompensated entropy, is apt. But work is an advantage, so that to call work that might be obtained ideally, and is not, uncompensated, is reversing the meaning of the term. The ungained work, $\text{W}_u = \int \theta d\phi_u$, where θ is, if the working substance is of uniform temperature, the temperature of the envelope or body. If the temperature is not uniform, θ is the temperature of each volume element in which the uncompensated entropy grows, and integration is carried out throughout the volume; but as the expression is important only when $\text{W}_u = 0$, the meaning of θ otherwise does not matter.

If a small change involves decrease of ungained work it is impossible; if the ungained work is zero, the substance and its externals are in equilibrium as far as that change goes; if the ungained work is positive the change is possible, and may take place in that direction only. As the ungained work does not, unfortunately, exist outside the substance, nor anywhere else as work, it is best not to call it W_u, but Δ or D. Then, if the ungained work is zero during a proposed change, the "thermodynamic potential" is said to remain constant. If the ungained work increases, the thermodynamic potential is said to decrease. The ungained work due to a small change may be represented in terms of the co-ordinates of the working substance.

$$\begin{aligned} d\Delta &= \theta d\phi - d\text{U} + d\text{W} \\ &= d\theta\phi - \phi d\theta - d\text{U} + d\text{W}. \end{aligned}$$

The external work, W, is general. It may be done electrically, or by expansion. If by expansion

$$d\text{W} = p dv = dpv - v dp.$$

Then $d\Delta = \theta d\phi - d\text{U} + d\text{W} = d\theta\phi - \phi d\theta - d\text{U} + d\text{W}$

(1) $d_\theta\Delta = d\theta\phi - d\text{U} - d\text{W}$

(2) $d_\phi\Delta = -d\text{U} - d\text{W}$

(3) $d_v\Delta = \theta d\phi - d\text{U}$

(4) $d_p\Delta = \theta d\phi - d\text{U} - dpv$

(5) $d_{\theta v}\Delta = d\theta\phi - d\text{U}$

(6) $d_{\theta p}\Delta = d\theta\phi - d\text{U} - dpv$

(7) $d_{\phi v}\Delta = -d\text{U}$

(8) $d_{\phi p}\Delta = -d\text{U} - dpv$

If the various partial differentials are taken as zero, the condition of equilibrium, and the right hand terms, integrated without adding any constants, and reversed in sign so that their decrease corresponds with increase of ungained work, eight more thermodynamic potentials are involved. No. 5 gives what is now called "free energy." It is not energy, and is in no way remarkable for freedom of any kind. The results of 5, 6, and one of the others, I do not remember which, are the Gibbs's functions, which have been called, first by Prof. Duhem, I believe, thermodynamic potentials, no doubt because they are constant for equilibrium, like potential in mechanics. Again, it is submitted with much deference, that the name is misleading. If the signs were not reversed, stabilities, or stability functions, might be a better name. Besides, the term potential is getting worn out. Counting the eight potentials just given as one specimen, I can think of nine kinds of potential used in physics, and a collector could doubtless find many more. They have various meanings and dimensions. Four or five of them belong to thermodynamics. If we have very many more potentials, the term may become a little difficult to define accurately and succinctly, though it is always impressive.

By defining entropy first in terms of the waste, and dealing with the increase of entropy of an isolated system first, and coming to the relation of increase of entropy to heat taken in reversibly later, the chance of confusing entropy with $\int d\text{H}/\theta$ generally, and supposing entropy is a factor of heat is avoided. This prepares the way for discussing the real factors of heat, such that $\int \theta d\chi = \text{U}$, where θ is the tension and χ the quantity factor. In other branches of physics, not only is $\int a db = \text{W}$, where a and b are tension and quantity factors,

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* Or whoever is responsible. As this is written away from home, during a holiday, references cannot be checked; any slips of memory or inaccuracies due to the circumstances, will, it is hoped, be pardoned.

† I think the term is due to Prof. Duhem, but my memory may be at fault.

but where c is capacity for the quantity, so that $db/da = c$, $\int c da = W$, or when c is constant, $W = \frac{1}{2}a^2c$. In that case the tension factor is $\sqrt{\theta} = \tau$, and the corresponding quantity factor π so that $\int \tau d\pi = U$. In a change where there is no external work done and no ungained work χ is numerically equal to ϕ, and is the logarithm of the square of some sort of equivalent velocity of the particles. Thus in the case of a perfect gas the entropy depends on the logarithm of the square of the equivalent speed, and the logarithm of the equivalent free path of the particles of the gas if there is one, or of each if there are more.

The frequency of collision has to do with external work, and χ depends only on the speeds. The physical meaning of τ and π is much simpler; τ varies as the equivalent speed, and π as the equivalent momentum.

Take the case of chemical energy as one of the forms of heat. U can be divided up into U_s, U_l, U_c for sensible, latent and chemical heat. $\int \theta d\chi_s = U_s$; $\int \tau d\pi_c = U_c$ and so on. At present heats* of combustion or combination are given in the lump. In the future we may have tables giving the θ and χ or the τ and π of each free element, and their change on reaction; or even their θ and ϕ. Then we would know beforehand in which direction each reaction would go. The question of the factors of heat need not be discussed here; it is a large subject by itself.

Heat Conduction.

If a body is conducting heat steadily, for instance, a uniform bar with one end kept hot and the other cold and no side leakage, the bar can be cut up into lengths by cross cuts imagined so that each cut is at uniform temperature. Let one be at θ_1 and the next at θ_2, and let heat H pass per second. Every second H/θ_1 comes in and H/θ_2 comes out, so that there is a volume growth of entropy depending on the conductivity and the temperature gradient. Any body whatever which is not at uniform temperature can be divided up into elements bounded by two sides each with no temperature gradient, and a bounding surface parallel to the flow of heat, so that there is no passage of heat across. If H is the heat in joules passing through the element, and $\theta + d\theta$ and θ the temperature of the two faces, the volume increase of uncompensated entropy per second, is $Hd\theta/\theta$, and the ungained work is $Hd\theta$ per second, or the ungained power is $Hd\theta$ watts. Integration throughout the volume gives the total ungained power.

Units.

The fact that the units in thermodynamics have no names goes to show that the science is not fully developed. Measurement is an essential of science.

There is no name for the unit of difference of temperature. Trigonometry and heat alone use "degrees." Marks or notches would not be less barbarous. Then there is no name for differences of temperature according to the absolute Kelvin scale.

The practical unit of heat, on the C.G.S. system, is the joule, but this is hardly ever used in thermodynamics. The calorie is a survival of the days when it was not fully realised that heat is energy. It involves an unnecessary and troublesome coefficient, and people are putting big calories and little calories, and, perhaps, intermediate calories into circulation.

There is no unit of entropy. I would suggest the claus; a claus being the entropy which incurs a waste of 1 joule at a lowest available temperature of unity; *e.g.*, if the lowest available temperature is 200 absolute, and the entropy 10, the incurred waste is 2,000 joules.

Conclusion.

Though this paper is a mere sketch, it is still hoped that enough has been said to show the importance of making an inherently difficult subject as easy to understand as possible; and it is also hoped that the somewhat novel way of arranging and treating the subject matter of the groundwork of thermodynamics may meet with the approval of those who specially deal with that science.

* This is another example of the extraordinary looseness of terminology that runs through thermodynamics. They ought to be colds of combustion or combination, for the heat of fusion or vaporisation is the heat taken in during the change. The so-called heat of chemical change is given out during the change.

NEW MOVING-COIL INSTRUMENTS AND TESTING SETS.

A number of ingenious and important improvements have been introduced recently into the design of horizontal galvanometers and testing sets by Mr. R W. Paul, of 68, High Holborn, London, W.C. The most noteworthy innovation is a horizontal portable galvanometer, with a moving-coil supported at its centre of gravity on a single pivot, and controlled by a spring. It is very compact, being of the same size and shape as the well-known "Post Office" type; it has, in fact, been adopted by the Post Office Telegraphs Department, after extended trials.

The accompanying figs. 1 and 2 illustrate respectively the plan and cross-section of the complete instrument. The base A is fitted with a glazed cover B which is attached by a bayonet joint, and secured from accidental opening by a screw. The magnet D, the polar surfaces of which are bored, is screwed to a brass spider C, which in turn is secured to the base. This magnet is of the highest quality and thoroughly aged before use. The soft iron core E consists of two hemispheres bolted together by the iron bolt G, one end of which is squared into the brass cock F. The circular coil H is wound on a metallic former, fitted with a radial spindle on the end of which is a jewel, which turns on the pivot K at the centre of the spherical core. The pivot is screwed into the bolt G, which has an oval recess to give the clearance necessary for placing the coil on its pivot when the front hemisphere is removed.

Attached to the top of the coil is a pointer-clip and counterweight for the pointer L, which plays over the scale M. A mirror, seen through a slot in the scale, is provided to avoid parallax in reading. To the upper end of the spindle carrying the coil, and insulated from it by an ivory collar, is an attachment for the bronze spiral spring N which gives the controlling force for the coil, the other end of the spring being attached to the torsion head O by means of which the pointer may be set to zero. This head is also provided with a lug for the attachment of a connection to

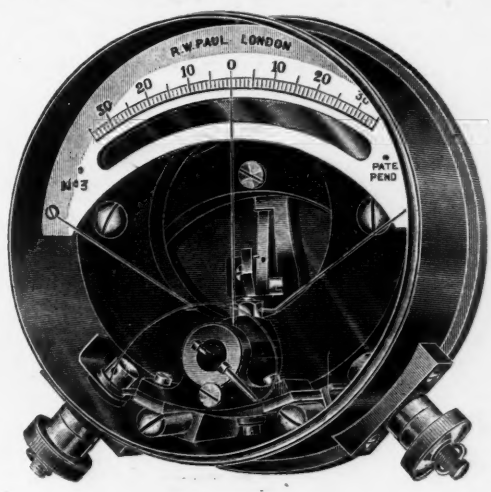


Fig. 1.

an insulated contact plate. On the other side of the cock-piece F, and also insulated from it, is carried a similar contact plate; the second connection to the coil, formed of a flexible silver strip, is soldered to the end of this plate. The working parts are entirely insulated from the case.

Two insulated terminals are fixed to the cover, each carrying a platinum-faced contact spring, which is arranged to slide over platinum points on the contact plates, and to make connection through them to the coil when the cover is put in place.

The cock-piece may be readily removed, together with the working parts, by unscrewing two nuts; the stud-screws holding it are of sufficient length to prevent accidental contact of the coil with the magnet while being lifted out.

The lifter, or clamp, consists of a plunger U which is raised when the instrument is set on a fairly flat surface, lifting the lever W against the action of the spring V, and allowing the light spring Y to drop and thus gradually to lower the jewel on to its pivot. The leather travelling case supplied with the instrument is so arranged that, whichever way the instrument may be placed in the case, the coil cannot be accidentally released by jarring or external pressure, nor can damage to the pivot be caused by a violent blow or fall.

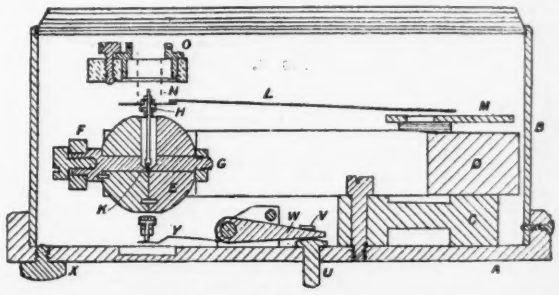


Fig. 2.

Amongst the special advantages of the centre-mounting are the facility for relieving the pivot of the weight of the coil during transit, the reduced friction, and the very small clearance which is required, enabling the air gap to be reduced to a minimum; the small clearance is at the same time effective in absolutely preventing the coil from being jarred off the pivot. Compared with the ordinary P.O. galvanometer, the instrument has no magnetic needle, and, therefore, requires no setting to zero; it is not affected by stray fields, is perfectly dead-beat, has a comparatively large and proportional scale, and is more sensitive.

The instrument may be tilted a considerable amount without affecting its working, as the circular coil may swing in any direction around the centre of the spherical core and cannot come into contact with it, while the pointer-tip being arranged nearly in a line with this

centre, any vibration produces little or no effect on its position. The galvanometer is, therefore, convenient for use on board ship.

With a coil of 60 ohms, one volt gives a deflection of 6° through 100,000 ohms, or one milli-volt applied to the terminals gives 10° deflection, and the instrument can be used as a direct-reading micro-amperemeter, milli-voltmeter, or megohm-meter. Certainly

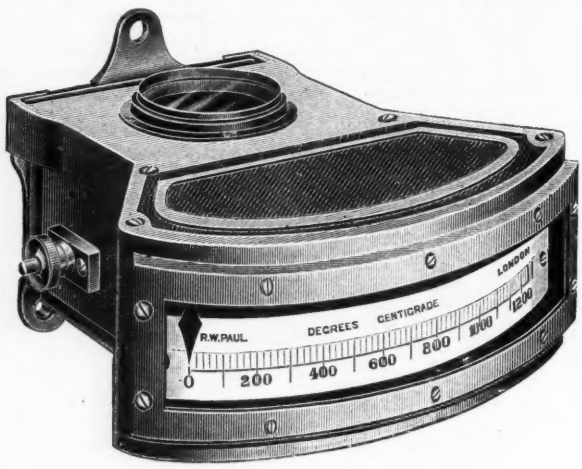


Fig. 3.

we have never seen a portable galvanometer that we liked better than—or so well as—this clever device.

The high sensitiveness and the absence of frictional error secured by this system of pivoting, but hitherto attained only by the use of a delicate and fragile suspension, have rendered possible the production of a series of portable direct-reading instruments which may, in industrial work, supplant reflecting galvanometers for many purposes. The working parts described above are mounted in cases of sector form, with either horizontal or vertical scales. We illustrate one of the latter pattern in fig. 3. This is intended to be fixed

Fig. 4.

on a wall, switchboard, or shelf. It is provided with a wall plate, as shown, to which it may be hooked, automatically releasing the coil. The example shown is for use with a thermo-couple pyrometer, but similar scales, the length of which is 5 in., may be furnished with graduations in micro-amperes, milli-amperes, milli-volts, megohms, &c. This type, which forms an excellent lecture-galvanometer, may also be fitted with a ballistic coil, rendering it available for the measurement of magnetic fields and general demonstration work.

The round pattern galvanometer is fitted up in conjunction with a new testing set, illustrated in fig. 4. The upper part of this, containing the galvanometer, forms a complete insulation testing set, and can be instantly detached from the remainder, which is a 3-dial Wheatstone bridge. A loose cover is provided, so that the insulation set (which is also manufactured as a separate instrument) can be carried about alone; the range of resistance measurable with this is from 5,000 ohms to 100 megohms, with a 100-volt battery, and pressures up to 500 volts can be used. A resistance of 10,000 ohms is permanently in series with the galvanometer, serving both to check the constant and to protect the coil, and a set of universal shunts is provided; the connections are shown in fig. 5. As the calibration of this galvanometer does not alter by change of position, it is only occasionally necessary to take the "constant" of the set, provided the same battery is used throughout a series of tests. The set is conveniently arranged for localising faults on mains. The bridge has a range of 0·1 to 99,900 ohms, and the dial switches are designed on a new system, embodying improvements in the coils, connections and rubbing contacts (see fig. 6).

The coils are wound on metal bobbins E, provided with lugs to which the ends of the coil are soldered, and with contact plates D, on which one end of a substantial switch brush, F, makes a rubbing contact. The opposite end presses on a central flange A, which supports the bobbins, the latter being insulated by an ebonite disc B. There is no circuit through the switch spindle, which is of

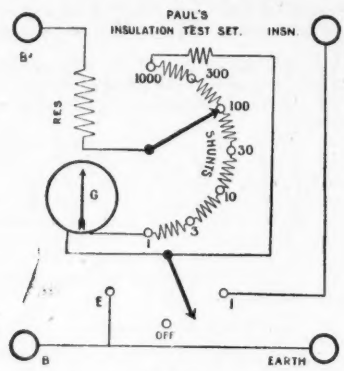


Fig. 5.

phosphor bronze, and is provided with an ebonite knob G, an index H, and a screw adjustment for taking up wear. The contact surfaces are entirely enclosed, but are conveniently accessible for cleaning. Only the knob and index project through the ebonite cover, on which the values of the coils are legibly engraved. As the ends of the coils are soldered directly to the bobbins, a damaged or burnt-out coil may be easily replaced.

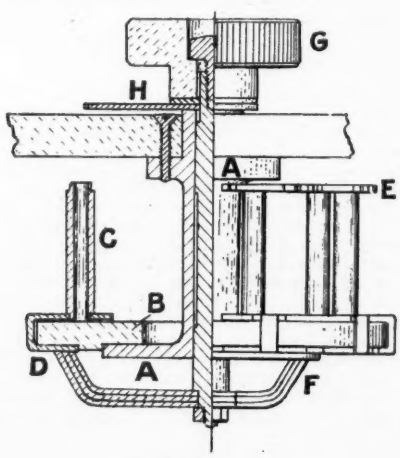


Fig. 6.

Mr. Paul has recently erected extensive works at New Southgate, and has issued a new catalogue, which will be of interest to most users of electrical testing gear; included are full descriptions of several new designs, including the Duddell-Mather standard watt-meters and anti-capacity gauze resistances, as well as revised patterns of his regular instruments.

THE ELECTRICAL OUTLOOK IN GERMANY.

For several years past we have felt it our duty to place before our readers periodical reports of the latest phases of the electrical industry problem of Germany. To some who find it necessary, when there is so much to do, to skip or only passingly glance at a certain proportion of the articles appearing in the technical press, it may have seemed that we were devoting more space to the matter than it warranted. But those who have taken the trouble to closely scan our history of German electrical industrial progress and its lessons will have arrived at no such conclusion. The entire matter has from first to last been one of supreme importance, and when so much is being written about our foreign trade and the rivalry of Germany and other countries, we feel somewhat inclined to say that our own backward state in electrical engineering were better far than the incalculable harm which has come as the aftermath from unbridled speculative recklessness in Germany. In his

efforts to grow big, the Teuton took too big a bite at first, and now lives a lean life, having come, for a time, to the end of the available business. In making markets he has done much "dumping" here at profitless prices, a practice which may be regarded as carrying both a blessing and a curse. Our own progress has been spread over a longer period, the development of electric lighting and traction having had a more gradual growth, and we believe that its basis is infinitely sounder. We have sometimes thought that there was room in the library of the electrical engineer for a book on the German electrical trade and its vicissitudes as viewed through English spectacles, but, really, the facts are patent to all, and such a work is rendered unnecessary by the interesting contribution prepared by Herr Isidor Löwe in connection with the Hamburg meeting of the German Sociological Association, which is to be held this week. The following summary of his monograph was telegraphed to the *Times* by its Berlin correspondent on September 10th. We do not know with what authority Herr Löwe speaks, but if we accept his impressions of the outlook, then it is, indeed, a gloomy one for German electrical engineering.

Herr Isidor Löwe describes the extraordinary development which took place between 1895 and 1900. An "electrical fever" seemed to possess the world during this period, just as the railway fever did half a century ago. The number of electric light works in Germany increased from 180 to 774, and the number of connections for electric lamps from 602,986 to 2,623,893. There was a tenfold increase in the dynamos used in factories, and tramway companies everywhere substituted electric power for horse traction. Only five towns in Germany with over 40,000 inhabitants are now without electric street cars, and 17 towns whose population falls short of this number possess them. A large business has also been done in Russia, South America and South Africa. The advance of electrical industry gave constant employment to the machine building trades, and increased the demand for copper, lead, iron, coal, india-rubber, hemp and jute. Steam machinery benefited by the progress of its rival, since the engines in power stations are driven by steam. Competition, however, was very strong, even when the boom was at its highest, and rival firms sprang up in neighbouring countries, such as Austria. Production began to assume unhealthy dimensions. The electrical industry laid down new plant in order to provide the dynamos required by the machine building trade, which, in its turn, made special efforts to keep pace with the demands of the electrical industry for machines. Capital was in great request, and in order to create it, recourse was had to a number of ingenious devices.

Then came the year 1900. It was suddenly found that the supply of towns requiring electric light and power was exhausted, and that the application of electricity to tramway traction had been carried to a point at which it could no longer pay. The productive power of the electrical industry had, moreover, been seriously affected by the rise in the price of coal and iron. The want of a market stimulated the tendency to cut prices, and the evils consequent on inflated credit began to make their appearance. The fall in prices depreciated the value of the goods in stock, and some firms failed. It was now found that large capital sums were locked up in unremunerative plant, and that the portfolios of the companies producing electrical machinery were full of electric tramway shares which had been given in payment for work done. These shares had only to a very small extent been taken up by the public. Something was done to diminish the crisis by grouping companies together, with the inevitable result that large undertakings received some accession of strength, while the weaker ones were practically extinguished.

Herr Löwe is not over-sanguine as to the immediate future of the electrical industries. There is very little demand for new power stations or new tramways, not much is to be expected from the electric automobile, long-distance electric traction is only in the experimental stage, and the horizon is obscured by the clouds which hang over Germany's commercial policy. There is still room for development in the application of electricity to mining, but for the rest the industry must look for employment chiefly to the replacement of worn-out machinery. Herr Löwe does not anticipate any immediate recovery, which he thinks can only be brought about by some new departure in applied electricity.

Certainly Germany is not at the end of her electrical disasters. If the Russian firms obtain the exclusion privilege, German works which have sunk large sums of money in Russian branches stand to lose heavily. Only the other day it was stated by the general manager of the Lahmeyer Co., of Frankfort, that all the German electrical companies with Russian branches had been disillusionised, heavy losses having already resulted, whether these branches were conducted as sales bureaux for their original promoters, or whether formed as Russian companies with workshops in that country, so as to appear as Russian undertakings to more easily secure native orders. But on the top of all these losses, which have, no doubt, hit Russian manufacturers because of the undercutting of prices, the Russian electrical companies have turned upon the aggressor, and have petitioned the Government, praying that new branches of foreign works should no longer be permitted to be established, and that the foreign branches already located in Russia should be excluded from participating in competitions for public contracts. German engineers have been expressing apprehension that if the petition receives sufficient support, the Government may be disposed to sanction the application. The result of this, we are told, would be to practically close certain of the German branches in Russia, while the position of those already formed as Russian companies would also be unenviable.

CORRESPONDENCE.

English Porcelain Insulators.

Owing to holidays, I did not see Mr. W. Rooper's letter nor your "Notes" on the subject in time to reply in this week's issue.

Mr. Rooper's letter is concerned with telegraph insulators, about which I have not said anything. The problem of the manufacture of line insulators for the overhead transmission of electric power at high voltages is a much more difficult one than making telegraph insulators, and, although Mr. Rooper no doubt knows very much about the latter, I do not think he fully appreciates the difficulties to be got over in the other problem. I may say that the highly vitreous line insulators in use in America are all threaded internally. The general practice is to screw them on to a wooden pin. I did not suggest that porcelain telegraph insulators were used in England because glass ones could not be made. What I did say was, that the class of porcelain which will do for telegraph work will not do for overhead transmission of power; also, that insulators suitable for the latter class of work cannot at present be got of any English pottery. This is largely because there has been no demand for them in England. As, however, I have been endeavouring lately to secure high class electrical porcelain, the idea I had in making the remarks which have been objected to was to direct attention to a problem which is worthy of notice on the part of English manufacturers.

As regards the remarks under "Notes":—I did not recommend glass, as against porcelain, for use in England. In spite of your being able to bear out the statements of your two other correspondents, I am afraid that in several of them they are mistaken.

Charles C. Garrard.

Hollinwood, Lancashire,
September 9th, 1903.

In order to raise a clear issue, I commenced my letter upon Dr. Garrard's article by referring to certain definite statements which he has made about English porcelain, especially that it depends for its insulating properties almost entirely on the glaze, and I was able to show, from working experience, that he was wrong; now he qualifies his assertions, and says, "as far as I am aware." I think that I stand fully justified in having made a somewhat strong protest against the article. Dr. Garrard is doubtless in a position to know what porcelain is procurable in England; my complaint is, that he did not avail himself of his knowledge. I think I should have known had he applied to the principal makers for samples of their high-tension insulators. There are not "many" makers of porcelain in England, but a great deal of ware is called porcelain which has no right to the name. Possibly Dr. Garrard's statements were based on tests of some of this material.

Now Dr. Garrard says that "telegraph insulators have nothing in common with the class of porcelain used for overhead electrical transmission lines at high pressures." Is this so? The one quality upon which he so properly insists is that porcelain should be non-absorbent of moisture. With absorbent insulators (a contradiction in terms, by-the-bye), telegraphs could not be worked with the weak currents used. Telegraph insulators, therefore, demand the essential quality in common with high-tension insulators, and by their successful use in our damp climate, with unglazed surfaces inside and out, have proved that English porcelain possesses it. It appears to me that the two classes of insulators have everything in common excepting details of size and shape.

I did not use the expression "galvanometer test." The galvanometer, as we all know, is only the instrument which indicates the leakage through or over the insulator tested.

I did not witness the destructive experiments which I mentioned; the figures were given to me in a report. Of course, such voltages as the report mentioned could not have been applied for any length of time.

Dr. Garrard's suggestion that tests of English porcelain should be made and the results published in the REVIEW is an admirable one, and as soon as my testing apparatus is ready I shall be only too pleased to welcome Dr. Garrard, and to give him every facility for making tests.

John T. Harris.

Stone, Staffs., *September 14th*, 1903.

Smoke Abatement.

In my letter of last week bearing on this important subject, smoke abatement, affecting, as it must do, station engineers in their endeavour to work their boilers with the minimum of smoke, and at the same time economy in working, I concluded my letter with the following remarks:—"What is the good of fining steam users for creating a smoke nuisance if we cannot show them the remedy?"

In this letter I will endeavour to show you what I consider the best way out of the difficulty. I would suggest that the London County Council, or a body of eminent scientific men, should form a committee for the purpose of testing the so-called smoke-consuming apparatus, and that they should invite the manufacturers of these apparatus to a great public test of their respective patents. I append below a few suggestions for framing the rules:—

1. That the test should be an evaporative test by weighing the feed water and coal (quality of coal and temperature of water, and all other details, to be arranged hereafter by the engineers).
2. That the test should be a one day's test of 12 hours per patent on a particular class of boiler, the size and horse-power and working pressure to be decided by the Council.
3. That the committee find the site and boilers, and the competitors fit up their own patents themselves and at their own cost.
4. That the test should be held in London, or some other equally convenient place, to be chosen by the committee early next year. That it shall be well advertised, so as to give every smoke-consuming firm an opportunity of attending.
5. That the entrance fee shall be £25, or such sum to be arranged by the Council to go towards the cost of the test.
6. No prizes should be given, only awards of merit.
7. That little or no smoke should be made during the test, and that any firm making smoke for more than three minutes shall at once be disqualified.
8. That the decision of the Council should be final and decisive.

The above rules are only a rough outline, and mere suggestions. By these means we shall be able to determine if there is such a thing as an efficient smoke consumer in the market, which is doubtful.

E. A. S. Daniell.

Protection: A Reply to Mr. Byng.

I have read with much interest the article in your current issue, entitled "Protection: a Reply to Mr. Byng," as it is so far the best argument I have seen in favour of Free Trade.

I should like to point out, however, that the main argument is fallacious. After stating that money is only a labour-saving device, and going into the details of an ordinary business transaction, the writer says:—"Now, if at the end of the year the cheques payable to me exceed in value those made out by me to other people I have made a profit. And why? Simply because my imports have exceeded my exports." His imports of what? Cheques. Does not this show that his exports of *stuff* have exceeded his imports of *stuff?* And is it not in *stuff* that national imports and exports are measured?

But if the writer desires to include money with the articles of commerce, then surely the argument stands thus:—England is growing poorer. And why? Simply because her exports exceed her imports.

Truly, "The great stumbling block is in the confusion of terms brought about by the use of money."

J. S. Vincent.

September 14th, 1903.

Tangential Traction.

I have just read the short note which you append to my article on tangential traction in your issue of the 4th. inst. I think that my "optimism" is fully justified. The experiments that I witnessed, and the eulogistic opinions expressed by hundreds of most competent engineers, including many authorities on railway work, explain, and more than explain, my favourable opinion. Moreover, if you had, like M. Grassi, President of the Ferraris Prize Committee—this prize, it may be remarked *en passant*, having just been awarded to Messrs. Dulait, Rosenfeld and Zelenais for their system—if you had, I say, witnessed these experiments, you would have come to the same conclusion as the Ferraris Prize Committee and as myself.

E. Guarini.

[Our esteemed contributor has a right to his own opinions. For ourselves, we are not prepared to say that a system which comprises costly stators 9 ft. long × 1·6 ft. wide, sunk in the ground at intervals of 60 ft., or 88 to the mile, wound for a pressure of 1,300 to 2,000 volts (let alone *50,000 volts!!*): automatic switches breaking 50 amperes per stator at 1,400 volts at intervals of, say, three or four stators: and a propellor 64 ft. long, in 12 compartments, supported on special rails by 13 pairs of wheels, and connected by flexible joints, while maintained at a constant distance of 10 or 20 mm. (·4 or ·8 in.) from the stators—is within the bounds of practical and commercial possibilities. —EDS. ELEC. REV.]

Switchboard Attendants.

On reading the letter in your last issue on the subject of switchboard attendants, in which the writer states as his opinion that "the average switchboard attendant gets as much as he is worth," I felt impelled to take up the cudgels on behalf of that long-suffering body of men, of which I am a member.

Apparently your correspondent confuses voltmeter attendants with switchboard attendants, which may account for his statement that "no previous training is really necessary."

Most engineers will not take on a switchboard attendant unless he has had at least three or four years' electrical and mechanical training, and also preferably some previous central station experience as well.

I know personally of two stations in London where men holding the position of switchboard attendant are required regularly to take entire charge of shifts, and in one of them he is paid the munificent sum of 10s. to 15s. a week for so doing.

In some stations where so-called shift engineers, who are purely mechanical men, are in charge, when an electrical breakdown occurs, such as a heavy short on the mains, necessitating a shut down, he invariably has to depend on the switchboard attendant to put matters right, the said switchboard attendant probably getting half the money he is drawing per week.

I feel sure there are many in similar positions to myself who can endorse these remarks.

High Voltage.

I presume that your correspondent, who signs himself "H.T., C.C.," and states that switchboard attendants are only worth what they get, and require no training, is referring to those employed in generating stations only; for these invariably have shift engineers over them, and have very little to do in the way of responsibility. (Then I certainly agree with him that they are only worth what they get.) But the switchboard attendants employed in sub-stations are not only held responsible for the economical working and maintenance of the plant, but invariably for

the consumers' supply, and therefore, I think, it would not be advisable to employ an inexperienced man in a sub-station as switchboard attendant.

Sub-Station Attendant.

I beg to differ from "H.T., C.C.'s" statement which appeared in your last issue, which was to the effect that switchboard attendants require no previous training. Doubtless your correspondent has made a grievous error. His words might have appeared more truthful and worthy of publication had they been "voltmeter attendants require but an elementary knowledge."

Kilowatt.

The Qualifications of Teachers of Engineering.

According to the calendars of the various technical institutions, it seems that the "Sandwich system" of technical education is to be given a good trial during the ensuing session. Might not some of our professors of electrical *engineering* also spend a little time in the shops? This has occurred to my mind, as I see that the works' experience of the head of an electrical *engineering* department recently appointed amounts to three years spent as far back as 1884!

H.

Automatic Fire Alarms.

With regard to Mr. Oatway's letter which appeared in your "Correspondence" columns in the issue dated August 28th, I will ask you to insert the following remarks:—

I am surprised that Mr. Oatway challenges Mr. Siemens to reply to my letter, for as regards the Siemens system, I only repeated what Mr. Oatway had himself said, viz., that it is somewhat out of date and gradually falling into disuse, as practice has shown the inadequateness of non-automatic alarms in general. It was not my intention to arrive at an unfair conclusion, and I do not think that even "involuntarily," I have arrived at one. I admit that for all the systems except those that are more or less complicated—perhaps my idea was not clearly expressed—there is only one receiver at the fire station. But Mr. Oatway will no doubt admit that if every house in a town like London were in communication with the fire station, we should have either an overhead system sufficient to darken the air, or an underground one too extensive to be contained in the space at its disposal. Such a system cannot be compared with wireless telegraphy, which requires merely a few cubic decimetres of space for its receiver and transmitter. Moreover, with the ordinary systems the testing of hundreds of thousands of lines would mean an immense amount of work. With wireless telegraphy, on the other hand, nothing could be easier than to try with a bell whether the receiver at the station is in good working order and to ascertain (after the antenna has been separated, be it understood) whether the transmitters are working regularly; this can all be done at one place in a few moments. Although Mr. Oatway does not say how he proposes to give the alarm at the fire station when the line is not in working order, he seems to imply that there is little fear of interruptions of this kind. With regard to this, I adhere word for word to what I said in my former letter. I will content myself with placing side by side with Mr. Oatway's opinion that of M. Mollo, who is an electrical engineer and, what is more to the purpose, chief of the Naples Fire Brigade, as expressed in his "Nozioni di elettro-tecnica per uso dei vigili italiani" (Milan: Societa editrica Libraria, 1900), page 69:—

"It can be easily understood that if each alarm had a special line the result would be a very complicated service, that would be continually out of order, and of no practical use, as it would necessitate a most extensive and detailed system of surveillance."

This opinion, expressed by a man who has no personal interest in the matter, carries, I think, as much weight as Mr. Oatway's, who cannot make me forget that he constructs alarms with wires.

Mr. Oatway seems to be greatly interested in the question of interference in wireless telegraphy, and to think that it might lead to serious consequences. I will, therefore, consider this question in detail; at any rate, as far as my fire alarm is concerned.

The problem must be studied in two ways. Let us first consider the influence exercised upon the receiver at a fire station by lightning, by the simultaneous working of several alarms, or by that of commercial or other wireless telegraphy stations. As to the first contingency, we may remark that the absence of earth and the smallness of the antennæ (which are, however, sufficient for the short distances under consideration) would greatly lessen the chances of disturbances. Moreover, it is well known that these disturbances do not prevent the reading of a telegram. At the worst, they would only lead to false alarms. I will describe later on a means of avoiding this contingency. As regards the case of the simultaneous working of two alarms, in the first place, statistics show that this never occurs; and, secondly, it could be remedied by arranging the instruments in such a manner that a certain time would elapse before each transmitter would re-transmit its signal. During this time we could receive from another transmitter. As regards disturbances due to other stations, it is necessary in the first place to show that these other stations really exist, which is by no means certain. What may eventually come to pass in various towns cannot now be taken into account. Moreover, this drawback could be remedied (1) by syntonisation, which, even in the opinion of Captain Ferrié, its great opponent, is effectual for short distances. The fire station and all the alarm transmitters would be tuned alike; (2) by mechanical means, for instance, by arranging the automatic Morse in such a manner that it will only be released if the message is preceded by a certain signal or by regulating the receiver so that it shall only answer to signals longer than the usual ones, or again by combining the two methods. We will now consider the influence which the alarms can exercise on commercial or other stations. Here, again, it must be assumed that these other stations exist, which we dispute. But even if they do, the matter is of very little importance, as fires are comparatively rare occurrences, and the interference cannot in this case be of great consequence. Lastly, it can be remedied by syntony or by directing the waves towards the fire station, which, in default of my own appliances for short distances, can be done even with the aid of Hertzian reflectors.

As regards the question of economy, I wonder that Mr. Oatway did not refrain from speaking of it at all. For my part, I shall not go deeply into the question. It would be idle to discuss a point so simple and so universally admitted. Mr. Oatway takes care to put before you only the mean cost of this underground circuit of ¾ mile and of the apparatus. He tells you that the maintenance amounts to from £3 to £10 per subscriber, but he is silent about the cost of first establishment of the line, which it would be interesting to know, and which does not exist in the case of wireless telegraphy. These figures, which Mr. Oatway so carefully keeps back, I do not hesitate to give, as far as wireless telegraphy is concerned. *For the short distances involved*, the cost of the transmitter is about 500 fr., that of the single receiver at the fire station, about 1,000 fr., whilst the expenses of maintenance do not exceed from 5 fr. to 10 fr. per year per apparatus.

As to the objection that my apparatus could not "give notice of fire uniformly and immediately under any atmospheric and industrial conditions," which is the first and most essential demand of the Fire Prevention Congress of London with regard to fire alarms, I will appeal from Mr. Oatway badly informed to Mr. Oatway better informed. Besides the model described in detail in the *Practical Engineer* and *Electricity* only, where a mercury thermometer is mentioned, the most essential part of my apparatus is described as a wireless fire alarm characterised by the combination of *any* apparatus susceptible to heat with a wireless telegraph transmitter, acting at a distance automatically and without wires upon a receiver at the fire station or any place required. Mr. Oatway claims to possess the best detector in existence. I do not wish to contradict him, but there is nothing to prevent the best detector in existence—Mr. Oatway's, for instance—from being added to the other advantages of my apparatus.

Mr. Oatway urges that firemen are inexperienced in telegraphy. Do they require less experience to read ordinary

messages than wireless ones? Besides, the economical advantages of wireless telegraphy are such that the companies installing the apparatus could very well maintain at the stations at their own expense—if the charge weighed too heavily on the fire brigade—professional telegraph operators. Mr. Oatway also brings forward the telegraph monopoly possessed by the Postmaster-General, and the necessity of obtaining his consent. I am ready to ask for his sanction as soon as my instruments are ready to be tested. I do not know, however, whether his intervention in the matter can be justified. Apart from the pecuniary question, which is of very little importance, and should not in my opinion even be taken into account, for the thought of wishing to profit by the misfortunes of others seems odious to me, I cannot imagine a police inspector or any one else coming to ask me to produce my authorisation from the Postmaster-General if, in the case of a fire near the fire station, I should call the attention of the brigade by using my voice or making gestures. This would also be wireless telegraphy; it would merely be acoustic or optical instead of electrical, that is all. In the case of the ordinary fire-alarms, the intervention of the Postmaster-General is fully justified, since, leaving out of the question the abuses that would probably result, the employment of innumerable overhead or underground wires would become a public nuisance. Mr. Oatway almost makes me forget that my system does not apply to the British Isles alone, but to other countries as well, including those in which the Postmaster-General has no voice in the matter.

In short, even if I had not the support of several eminent technical men, Mr. Oatway's suggestions would in no way discourage me. I even thank him for them, as well as for the wishes he expresses on my behalf. I shall hope soon to see Mr. Oatway favouring the invention of which he now disapproves. In doing this, he would only be following many illustrious examples, of whom the most illustrious would assuredly be Edison, once the opponent of wireless telegraphy and of Marconi, now their defender, and I congratulate him warmly on his change of opinion, at which there is nothing to be astonished. At first, Edison, the opponent of wireless telegraphy, saw it applied, under other names and other forms; now, Edison, a member of the American Marconi Co., defends Marconi and wireless telegraphy, and, in so doing, defends his own work and his own interests. May the submarine cable companies—since he is among their most distinguished inventors—and Mr. Oatway, do the same!

E. Guarini.

Brussels.

Ramsgate Tramcar Accident.

Allow me to correct first Mr. N. D. Cameron's statement that the decision of the Manchester Corporation to equip a small number of cars with the brake Mr. Cameron's company pushes with such admirable energy was the outcome of a favourable comparison at trials. As a matter of fact, the combined pneumatic wheel and track brake was declared by the officials who tested it to be the best brake they had ever known. On the other hand, it was known long before this trial came off that a magnetic brake would first be tried on a larger scale before the more expensive pneumatic brake would be taken into consideration. This was even hinted at when the makers of the pneumatic brake applied for permission to be allowed to fit one car with such a brake.

After the trials made by the technical officials and by the manager, the makers of this brake were asked to quote for a large number of these brakes. I believe it was 100 equipments, a request the management would not have made had they considered the brake outclassed.

I need only state that the makers of the combined brake had reasons to give only an approximate price, and that this brake was consequently *not tested* at the Committee trials, to fully disprove Mr. Cameron's hint that his magnetic brake scored at these trials. Quite the contrary; his trial brake had come in disabled on the previous evening, and workmen were still busy repairing it one hour before the Committee arrived at the car-shed. I am certain that the brake did not pull up within 30 ft. on that occasion.

Turning to the statement that only 30 amperes maximum are required to stop a 10-ton car travelling at 15 miles an hour in 30 ft., I invite Mr. Cameron to show the theoretical possibility of annihilating the enormous energy represented by the 10-ton car moving at 15 miles an hour with the paltry amount represented by a current starting with 30 amperes and the probably corresponding 100 volts and rapidly dwindling down to naught. I also invite Mr. Cameron to say how he measured the 30 ft., as tramway men are generally quite contented to state such distances within a yard or two.

The reasons Mr. Cameron states why air brakes should be the right thing for railways and wrong for trams are hardly convincing.

Having only one car to provide with compressed air, the compressor on a tramcar can be worked at a fraction of the pressure which it has to contend with on railway trains. That there are more stops made on tram lines than on railways matters very little, if we consider how many times more air is required for each stop of a railway train, and how much more leakage has to be made up for in the many brake cylinders and couplings of a train.

But where tramcars offer such marked advantages to the pneumatic brake is by the direct action of the air from the simple controller valve to brake cylinder, while railway trains must be provided with a complicated master valve and auxiliary valves on every car. It is well known that these valves give most trouble on railways, and their absence on trams must be considered a great advantage.

Another great advantage every brake has on tramcars is, that it can be inspected daily, and is never more than a few miles from the repairing shop.

It is hardly necessary to spend much breath over Mr. Cameron's claim, in his first letter, that his magnetic brake is a champion. To begin with, it does not satisfy the Board of Trade, as is clear from the Ramsgate inquiry; secondly, it does not fulfil several very desirable requirements which pneumatic brakes fulfil.

Mr. Cameron himself admits that a car cannot be held on a fair gradient with the magnetic brake, and that the motorman has to handle a second brake. He denies that this is a nuisance; but what did the Ramsgate inquiry prove?

It should, however, be noted that Mr. Cameron only states that this performance *can* be produced with 30 amperes, but not that the average driver succeeds to anything near to this economy. There is no denial that 200 amperes and more may be employed. I leave it to those interested to find out for themselves what currents are actually occurring, and how far they conduce to long life of motors.

Air and Sand.

September 15th, 1903.

[A correspondent wants to know who are the makers of "Empire cloth paper" for cables.—Eds. Elec. Rev.]

BUSINESS NOTES.

Steam Turbine Plant for Lighting Stations.—At Anderson, Indiana, U.S.A., the increasing demand for light and power has rendered the present municipal plant (comprising two belted generating units) entirely inadequate, and to secure relief from these conditions two Westinghouse steam turbine generating units, each of 400-kw. capacity, are being installed, together with a 20-kw. exciter direct connected to a Westinghouse standard engine. By the employment of turbines, extensions to the power house itself have been rendered unnecessary, the capacity of the plant at the same time being largely increased. In addition, room is made for the installation of a complete boiler plant in the electric light building, thus making the operation of the lighting system entirely independent of the waterworks—previously the steam power was furnished by the boilers of the latter plant. The new additions consist of three 310-h.p. Stirling water-tube boilers equipped with Roney mechanical stokers. They are being arranged to supply saturated steam to the turbines at 150 lbs. pressure, all condensation being returned to the boilers by a steam loop and Holly gravity system. Surface condensers will be used, and as the exhaust will be free from oil the condensed water can be delivered direct to the boilers as hot feed. Three-phase current will be furnished by the turbo-generators at 2,200 volts pressure, 120 periods. The great feature of the generating station lies in the fact that by substituting turbines for the old belted units, not only is sufficient space made available for the installation of a complete boiler plant, but room is left for possible future extensions without additions to the power house itself.

Electrical Wares Exported.

Week ending Sept. 16th, 1902.	Value
Alexandria	£42
Amsterdam	158
Bombay	20
,, Teleg. wire	710
Buenos Ayres	430
Calcutta	563
Cape Town. Teleg. mat.	356
Channel Islands	317
Christchurch	55
Colombo	108
Durban	469
,, Teleg. mat.	3,156
East London	1,341
Flushing	22
Gothenburg. Teleph. cable	219
Hamburg. Teleg. mat.	800
Melbourne	166
New York	105
North Atlantic. Teleg. cable	2,500
Oporto	70
Otago	24
Port Elizabeth	85
Shanghai	400
Stockholm	78
,, Teleph. cable	161
Sydney	857
Yokohama	3,815
Total	£16,927

Week ending Sept. 15th, 1903.	Value
Amsterdam	£25
Auckland	274
Bombay	85
Calcutta	3,614
Cape Town	672
Cologne	17
Colombo	458
Constantinople	60
Delagoa Bay	44
Durban	1,594
,, Teleg. mat.	851
East London	6
Genoa	20
Hong Kong	19
Lyttleton	93
Melbourne	300
Nagasaki	263
North Atlantic. 66½ miles submarine teleg. cable	—
Ostend	56
Perth	805
Port Darwin	60
Port Elizabeth. Teleg. mat.	1,739
Santander	59
Spezia. Elec. primers	86
Sydney	71
,, Teleph. cable	693
Toronto	14
Wellington	257
Westport	805
,, Teleg. wire	579
Yokohama	85
,, Teleg. wire	718
Total	£12,872

Foreign Goods Transhipped.

Gothenburg. Elec. appar... Value £206 | Progresso. Telephones .. Value £164

Ediswan Fittings.—Every fittings manufacturer who wishes to keep in touch with the public tastes and requirements must be continually bringing out something new. Such a course is adopted by the Edison & Swan United Electric Light Co., Ltd., at whose showrooms in 36 and 37, Queen St., E.C., numerous new and artistic fittings may be seen. Of course, *l'art nouveau* hand-hammered work stands pre-eminent, and the special feature about the work is that the whole is hand-made from start to finish, and not, as is sometimes the case, stamped first and "bumped up" afterwards. Excellent models of Louis XIV., XV. and XVI. brackets can also be seen, together with Adams's and the lighter cast work. Special notice should be given to the antique finishes which are exhibited—*i.e*, antique copper, antique brass, antique silver and antique iron. The company is inviting the trade to inspect the new season's stocks. Herewith we give a few illustrations of some out of the many designs which are on view. Fig. 4 is a three-light antique iron and polished copper electrolier suitable for either a dining-room or library; the whole is hand work. Fig. 3 is a two-light bracket, with antique iron finish. The artistic lines and curves displayed in this fitting will commend it to our readers' taste. The shades shown on the fitting also harmonise, and the company seems to pay great attention to small artistic details. Figs. 1 and 2 show lanterns suitable for entrances; both are finished in antique iron, but they, like any of the other fittings, can be made in any metal or any finish. The company pays special attention to the protection of trade interests. The trade discount is reserved solely to *bonâ-fide* traders, so that a contractor can with safety send his clients to the showrooms, and rest assured that his "consideration" will be reserved to him.

Fig. 3.

Fig. 1. Fig. 2. Fig. 4.

Ediswan Fittings.

Royce's Motor Works.—Messrs. Royce, Ltd., have now completed and started up the new works which they have erected at Trafford Park, Manchester, for the manufacture of dynamos and motors in quantities. The works, which cover a large area and include a fully equipped iron foundry, are electrically driven throughout, have been expressly designed with a view to promoting rapid and economical production, and are equipped with a splendid selection of the latest automatic and other machine tools and labour-saving devices. The resultant economy in the manufacture of Messrs. Royce's standard lines of machines has been such as to enable them to considerably reduce prices without diminishing the quality, to meet the keen competition at present prevailing.

Queen Anne's Chambers.—The contract for electric light and power wiring at Queen's Anne's Chambers, Westminster, has been placed with the British Electric and Telephone Co. These buildings, which, when completed, will be one of the largest blocks of offices in the world, occupy the greater portion of the site bounded by Broadway, Tothill Street, New Tothill Street and Dacre Street, Westminster. The electric passenger elevators are being erected by Messrs. Waygood & Otis. This work is being carried out to the specification, and under the direction, of Mr. B. H. Rolfe, M.A., consulting engineer to Messrs. Rolfe & Matthews, of 3, Adelaide Street, W.C.

Bankruptcy Proceedings.—James Pollock, electrical engineer, 196A, St. Vincent Street, Glasgow, was examined in bankruptcy before Sheriff Thomson, in the Sheriffs' Court, on Monday, 14th inst. Bankrupt stated that he commenced business 18 years ago. He had no capital, but gathered stock by his own labours. At first he did work for firms that did not keep a staff of their own, and he gradually got a connection in this way. He prepared balance-sheets regularly every year up till 1898 or 1899; they were made up by an accountant, and the last one struck showed a capital of £1,500. He sold some telephones to the National Telephone Co. for £1,375, part of which he sunk in purchasing new works. He paid £300 for them, and he also took over a house attached to the works for £470. He carried on the works for two years, during which he lost £1,100. He also carried on a clock business, in which he lost £1,500 on bogus orders. He had resolved on sequestration because of three creditors pressing him very hard. But for that, he thought he could have paid every creditor in full. The state of affairs showed liabilities £2,156, and assets £268 0s. 5d.

Sherman v. Lowenstein.—In the Vacation Court on Wednesday Mr. Justice Buckhill was asked to appoint a receiver of the property and assets of a partnership business, which had been formed to manufacture electric dry batteries. The partnership had been dissolved, but there was a question between the parties as to the ownership of certain batteries. His Lordship did not think the matter was particularly urgent, but after some discussion he agreed to appoint the plaintiff's receiver.

Coney Island, N.Y.—In a recent issue of the *Brooklyn Edison* the attractions of Coney Island are eulogised, and the flood of illumination which is provided at night time with almost profligate extravagance is cleverly illustrated by a series of coloured prints from photographs taken after sunset. Coney Island was once a barren waste, but has been converted into a most attractive pleasure resort, pleasant enough by day, but a dream of brilliancy by night. The latter, of course, is wholly derived from the Edison Co.'s electric service.

Annual Dinner.—The annual dinner of the staff of Messrs. De Grelle, Houdret & Co., London Wall, E.C., took place on Saturday last at the Duke's Head, Walton-on-Thames. Previous to the dinner a cricket match took place, Married *v.* Single, and proved in favour of the latter by 2 runs. This result is hardly good enough to be of much assistance to the cause of bachelordom among the staff. After dinner, which was favoured by Mr. Henry De Grelle and Mr. Jules Houdret, jun., the former alluded, in feeling terms, to the loss the firm had sustained by the death of the late Mr. George Beesley a short time ago. Mr. Bowles proposed the toast of the prosperity of the firm, coupled with the name of Mr. De Grelle, to which that gentleman replied in well-chosen words, at the same time offering, on behalf of the firm, a subscription towards the formation of a permanent cricket club.

Bastian Meters.—The Bastian Meter Co., Ltd., has lately received contracts for the supply of meters of 10 amperes capacity to the following places:—Melrose, Jedburgh, Dalkeith and Dollar, and the London County Council Cottages, at the Sewage Outfall Works, Crossness.

The "Parlyphone."—Small telephone sets, like small arc lamps and small profits, have been a leading feature in the electrical trade of late, and, as might be supposed, the Berliner Telephone Manufacturing Co. has not been backward in responding to the call. The accompanying illustrations show the "Parlyphone," a hand combination which is suitable for use in conjunction with

Fig. 1.

Fig. 2.

the ordinary electric bell circuits in houses, shops, &c. Fig. 1 shows the instrument suspended from the bell-push at the calling station, and fig. 2 the corresponding arrangement at the answering end near the bell or indicator. Figs. 3 and 4 are diagrams of the

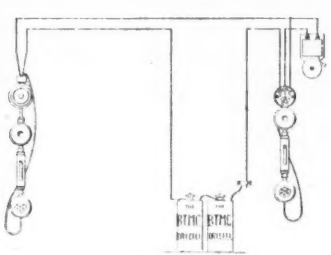


Fig. 3.

connections used respectively with a single bell circuit, and with a number of circuits and an indicator. Both sets have keys in the handles, which must be depressed when speaking. The receivers have double-pole permanent magnets, and with the transmitters are

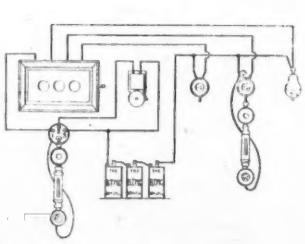


Fig. 4.

designed to work satisfactorily with the ordinary bell batteries. We have tested these sets, and found the speaking remarkably clear and audible, while their appearance is much above that of the ordinary run. The idea appears to have so thoroughly "caught on" that in our opinion the small telephone set will in future become an important feature in private telephone enterprise. Incidentally, the Berliner Co. has crowded itself out of its present premises, and has removed into a much larger establishment at No. 200, Upper Thames Street, where the whole building will be utilised for showrooms, stores and general offices.

Catalogues and Lists.—The General Electric Co., Ltd., has just published two new lists. No. P. 1,039 is devoted to the "Witton" continuous-current dynamos, and it is a "sister" list to the "Witton" continuous-current motor catalogue issued some time ago. There is a clear and concise specification of the dynamos, of which the company makes two types, viz., the open protected pattern for small outputs, and the open multipolar pattern for large outputs. These machines have been standardised in a large variety of sizes for 110, 220 and 440 volts, and also for 140 volts in connection with accumulator charging. They are all built on the latest and most approved designs, all parts being interchangeable and made to gauge. The numerous tables of dimensions, prices, &c., are clearly arranged, some considerable trouble having been taken to set out in detail for the use of customers, weights, shipping dimensions, and linear dimensions of the various sizes, and a table of spare parts and accessories. The other circular (No. E 1,042) is of especial moment as it is a list of English-made arc lamp carbons. As our readers are fully aware, the company has laid down at Witton, near Birmingham, a factory based on the latest and most up-to-date Continental experience; it is now in a position to supply arc lamp carbons of its own Witton make. The list shows three qualities, viz., a "standard" and a "special" quality, and a third quality which is specially recommended for enclosed arc lamps. The company expresses itself as being confident that users of arc lamp carbons will prefer to purchase carbons made in this country, and thus be independent of the fluctuations of prices due to strikes, &c., on the Continent, and also that they will appreciate the advantages of quick delivery. One reason given in the list why the English-made Witton carbons should be used is "because they are no dearer than Continental-made carbons."

The Howard asphalt solid system is explained, and the advantages of the troughing system are enumerated, in a well got up booklet just compiled by the Howard Conduit Co., Ltd., of Trafford Park. Some good photographic views, showing laying operations in process, a series of letters from engineers expressing their satisfaction with the system, and a list of some of the more important of the company's customers, including Government and other public departments, municipal and other electric lighting undertakings, &c, are given.

Messrs. Fredk. Thomas & Co., of the Enterprise Art Metal Works, 189, Drummond Street, N.W., who have been manufacturers of electrical art metal work for the past 12 years, have sent us a number of illustrated sheets showing numerous designs of electric lighting fittings. These are advance sheets from a catalogue which is now preparing for publication, and they show some artistic designs of pendants, lanterns and ceiling counterweight fittings. The firm's works are equipped with modern plant and machinery, and a large stock of raw material is held in readiness for turning out work promptly.

Messrs. Laurence, Scott & Co., Ltd., of Norwich, have just issued a new circular showing some of their specialities, including motor winches, as made for H.M. new yacht *Victoria and Albert*, with patent interlocking hand-brake gear and drum controller. Some views of their standard lines of motors, such as they have supplied in large numbers to Vickers, Sons & Maxim, Cadburys, and the Birmingham Small Arms Co., appear.

A catalogue of hand, hydraulic and electric lifts, hoists, cranes, &c., has been published by the Safety Lift and Elevator Co. (M. T. Medway), of Albert Works, Rolt Street, Deptford. Electric lifts for passenger and goods service, direct coupled, with patent lift controller, electro-magnetic brake, over-travel trip switches, and for continuous or alternating current circuits are detailed and illustrated. The book also contains a description of an electrically-driven friction hoist, and a variety of hoisting machinery such as to make it useful to architects and engineers who have to do with the erection and equipment of large buildings where lifts are a necessity.

A new pamphlet (No. 48) has been sent to us by Messrs. Ernest Scott & Mountain, Ltd., of Newcastle-on-Tyne, containing a description of electrical plant which they have supplied for the Polton Colliery of the Lothian Coal Co. The installation comprises a 130-I.H.P. horizontal engine driving by belt a 70-KW. continuous current dynamo, and a 75-H.P. motor driving a set of duplex centrifugal pumps.

A new list which has been brought out by the Dowsing Radiant Heat Co., Ltd, of Budge Row, E.C., places before the trade and users generally several new and neat types of these well-known luminous electric radiators. As the season is now at hand no doubt the list will be in demand among electrical installation contractors.

Messrs. Turner Bros., of 134, Upper Thames Street, have issued a catalogue giving dimensioned drawings of electrical sheets for dynamos and transformers, in squares and rectangles of dimensions up to 66 in. wide, including dynamo armature discs, laminated pole tips, stator and rotor and transformer stampings.

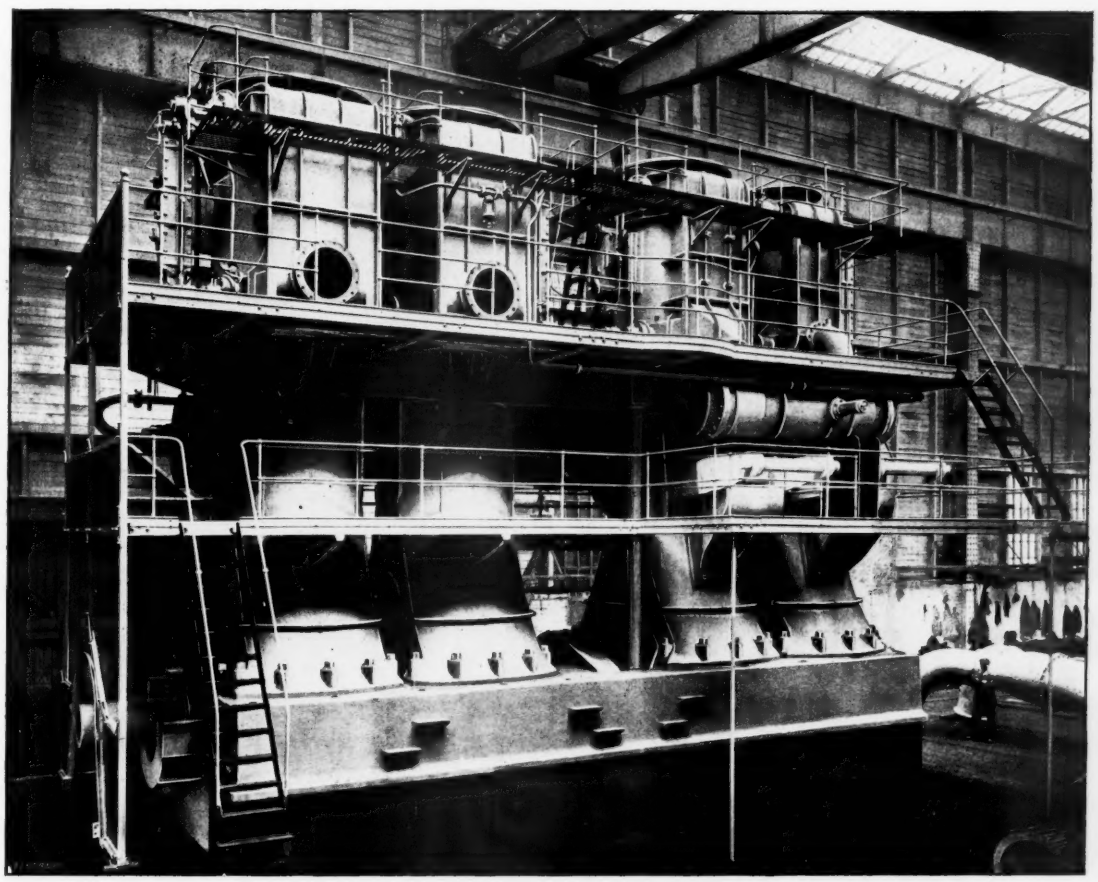
From Messrs. Offord, Wilson & Barfield, manufacturing electrical engineers, of 98, Woodcock Street, Birmingham, there has come to hand a list (20 pp.) giving illustrations and prices of a few of their specialities. These include automatic time switches, photographic arc lamps, resistances, measuring instruments, theatre lighting accessories, switch service fuses, main switches, electric lanterns, and so on. The firm make a numerous class of apparatus beyond those mentioned, and they also have a special repair department for dynamo and motor work.

(*Continued on page* 467.)

THE NEW ELECTRICITY WORKS OF THE MANCHESTER CORPORATION.

The article under the above title, in which, in June and July last, we gave an account of the recent developments at Manchester, will be fresh in the memory of our readers. Through the courtesy of the chief engineer, Mr. G. F. Metzger, we are now enabled to supplement it by illustrations and particulars of the large generating sets which are in course of erection in the new engine room at Stuart Street works.

The two main engines which were supplied by the Wallsend Slipway and Engineering Co., Ltd., and which are illustrated herewith, are of the triple-expansion vertical type, having four cylinders and four cranks each; the pressure for which they are designed is 190 lbs. per sq. in. at the stop valve, the steam being superheated to a temperature of 500° F. They will be used in conjunction with surface condensers, giving a vacuum of 27 in. The normal output of each engine is 6,000 I.H.P., running at 75 revs. per minute, and the emergency output 6,500 I.H.P. for two hours; when running non-condensing the output will be 5,000 I.H.P. The engine is mounted upon a cast-iron bed-plate of box pattern, provided with wells to catch waste oil; the corresponding alternator is mounted on independent bed-plates, with a main bearing on each side. The cylinders are fitted with hard cast-iron liners, and steam jacketed, except in the case of the low-pressure cylinders; the cylinder covers are also jacketed, and finished bright inside. Relief valves are fitted at both ends of each cylinder, and also on the receivers. All hot parts of the engines are lagged with sectional magnesia and covered with steel sheeting. Metallic packing is used in all the stuffing boxes. The pistons are of cast-iron, with cast-iron packing rings. The slippers are lined with white metal, and work in guides bored out to different centres to prevent the rods from turning. The main bearings are of gun-metal, carried in the bed-plate, and lined with white metal; water jackets are provided to all frictional parts for use if necessary. The crankshaft is of steel, bored hollow throughout, and special attention has been given to the balancing of the cranks; the valve gear is of the Corliss type, with provision for adjusting the cut-off from the switch-board. Each engine is fitted with two governors, driven from the crankshaft with positive gearing; one governor controls the speed within 2 per cent. from the mean between no load and full load, with a momentary run up of 5 per cent. when the full load is thrown off. Provision is made for adjusting the speed within a range of 5 per cent., up or down, by hand. The second governor is provided to prevent excessive speed being attained, in case of accident. The fly-wheel is mounted on the low-pressure end of the crank-shaft, and is designed to give an angular variation in one revolution not exceeding $\frac{1}{30}$. The air and circulating pumps are driven from the h.p. and i.p. cross-heads, as shown in the illustration. The engine is provided with forced lubrication throughout, at a pressure of 50 lbs. per sq. in., the oil pumps being direct driven from the shaft; auxiliary sight-feed lubricators are fitted to all parts. Electrically-driven oil pumps are provided between the oil



Wallsend Slipway Co.'s 6,000-H.P. Engine.

separator (exhaust steam) and the main engine oil tank. Steam separators are provided on the main steam pipes, and arrangements are made for working the main valves from any of the platforms. Tubular receivers for reheating the steam with live steam at boiler pressure are provided between the cylinders. Electrically-driven barring gear is provided for turning the engine. The guaranteed efficiency of each engine is at least 91 per cent., and the steam consumption is not to exceed 11 lbs. per I.H.P.-hour condensing, or 18 lbs. when non-condensing.

The very massive and imposing proportions of these fine engines, the largest yet installed for electrical generation in this country, are well shown in the illustration, though their shapely build tends to conceal their true magnitude; some idea of the latter, however, may be gathered by comparison with the stature of the workman standing in the background. The cylinders are 37, 59, and two 72-in. in diameter, and the stroke is 5 ft. The shaft measures 30 in. in diameter in the fly-wheel, and 21 in. at the journals. The engine is 32 ft. in height from the floor level, and 50 ft. over the air and circulating pumps in the basement.

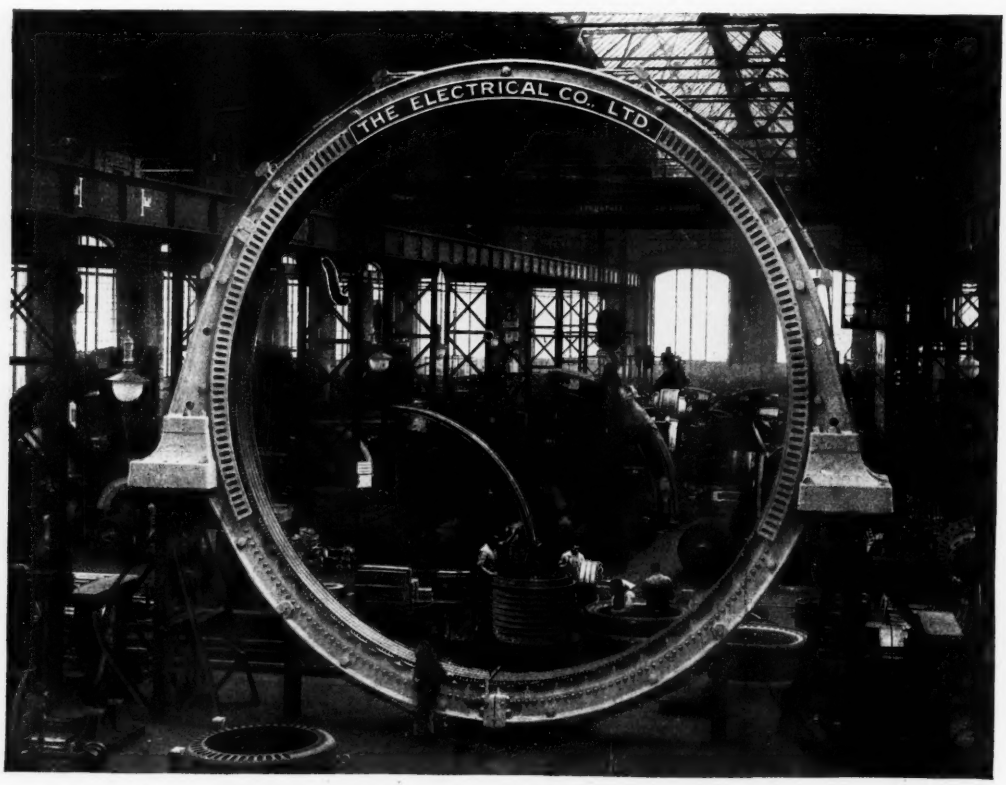
Mr. G. F. Metzger, A.M.I.C.E., M.I.E.E.,
City Electrical Engineer, Manchester.

The two alternators were supplied by the Electrical Co., Ltd., of London, and were built in the works of the Allgemeine Elektricitäts Gesellschaft, at Berlin; the accompanying view shows one of the armatures in course of erection at the makers' works. The alternators are of the three-phase type, generating at 6,300 — 6,600 volts, 50 cycles per second; the normal output is 3,750 KW., with a power factor of 0·87, and 4,250 KW. with a power factor of unity, while the emergency load for half an hour is 4,900 KW.

The armatures are of the stationary type, the magnets being carried on the periphery of the fly-wheel; the braced frame construction devised by the A.E.G. is used to support the armature core. The diameter of the rotating part of the generator is 27 ft., its weight being 110 tons, whilst the total outside dimension of the generator is 36 ft. 5 in. The winding of the armature is of the usual type, connected star-fashion. The field-magnets are excited from the auxiliary direct current service of the power station at 200—225 volts, and the power absorbed is specified not to exceed 36 KW., when the armature power factor is 0·87; the magnet poles are provided with amortisseurs to facilitate parallel running and prevent hunting. Automatic lubrication of the main bearings is provided.

The guaranteed performance of the machine is as follows:—

The temperature rise of any part of the machine above that of the surrounding air, after 24 hours' run at full normal current, is not to exceed 70° F. The mean fall or rise of pressure between no load and full load, or *vice versâ*, is not to be greater than 7½ per cent. with power factor unity, or 18 per cent. with a power factor of 0·87. The armature must stand a dead short circuit for two minutes without injury, and the current must not exceed four times the normal. The insulation tests include the application of 14,000 volts alternating for one hour between the armature circuits and earth, and between each other,



Armature of the Electrical Co's 3,750-kw. Alternator.

and 1,000 volts alternating between the field winding and earth.

The efficiencies are to be as follows :—

Power factor.	Full load.	Half load.	Quarter load.
0·87	97 %	95 %	91 %
1·0	97 %	96 %	94 %

The alternators must be able to endure an overload of 15 per cent. on emergency for half an hour, and are to be capable of running in parallel with each other and with the existing machinery, on non-inductive and inductive loads, and at all loads.

Particulars of the new engine room within which these large generating sets will be housed, and of the boilers and auxiliary plant which will be used in conjunction with them, were given in our article on the new electricity works of the Manchester Corporation, on p. 18 of the current volume.

Warren House.

It remains for us to say a few words anent the personality of the chief engineer, Mr. G. F. Metzger, who is responsible for the specifications and plans to which these generators and the other extensions now in progress are being constructed, as well as for the conduct of the whole of the huge electricity supply undertaking of the Manchester Corporation.

Warren House: Interior of Drawing Room.

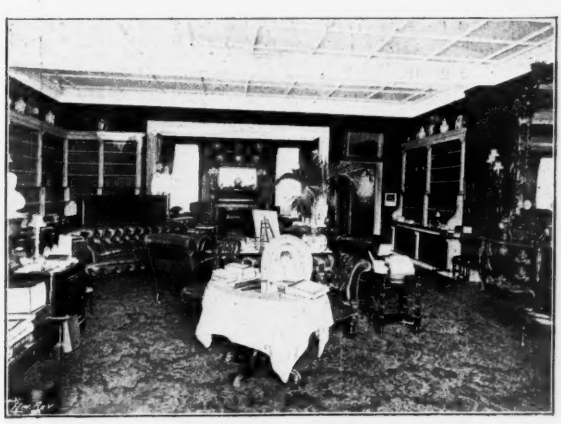
Mr. Metzger, although possessing a foreign name, is an Englishman, and served his complete engineering apprenticeship (from 1884 to 1889) at Messrs. J. & H. Gwynne's, Hammersmith Ironworks, London. He then entered the employ of the Metropolitan Electric Supply Co. as draughtsman for designing central stations in their area of supply, and was first promoted to their Whitehall station as an assistant engineer, and later served in a similar capacity at their Sardinia Street station, but finally held the position of station superintendent of the Whitehall works. He resigned this post to join the firm of Messrs. J. E. H. Gordon & Co., and was by them entrusted with the erection and running of the high pressure direct current system in the Crystal Palace during the Exhibition of 1892. Messrs. Gordon then sent Mr. Metzger to Bray, Ireland, where he was in sole charge of the cable laying, and the erection and subsequent working of the steam and water-power station. In 1893 he was appointed chief engineer and general manager to the Bath Electric Lighting and Engineering Co., and when, in January, 1897, those works were acquired by the Bath Corporation, they appointed him City Electrical Engineer, in which capacity he carried out all extensions to works, plant, cables, &c. In March, 1901, he was appointed City Electrical Engineer to the Corporation of Manchester, and is now responsible for the running of their three generating stations, viz, Dickinson Street Works (direct current), 13,600 H.P.; Bloom Street (direct current), 12,000 H.P.; and Stuart Street (three-phase current), 27,000 H.P., as well as the many sub-stations connected with the whole scheme. He is, at the present time, putting down the two 6,000-H.P. three-phase units, described above. Both lighting and tramways are supplied with power from the above-mentioned works, the total horse-power being 52,600, and the number of tramcars run, when all routes are completed, will be 700. On March 31st, 1903, the number of consumers was 4,541, and the units generated in the various stations during the previous 12 months amounted to over 22 millions. The tramway demand alone is expected to reach nearly 20 million units this year, and it will be seen, therefore, that Mr. Metzger holds the important position of being in charge of the largest electricity supply undertaking in this country.

A PRIVATE HOUSE PLANT.

An interesting example of a modern electric lighting installation is that of Warren House, near Hayes, Kent, the private residence of Mr. Martin Ridley Smith; some illustrations of the house and plant are given herewith. Messrs. Dolby & Williamson, of Westminster, were the consulting engineers. The contract covered the supply and erection of a complete generating plant and storage battery, as well as the wiring for lighting and other purposes. The house was originally lighted with gas, and, as an example of the scrap value of gas lighting installations, we may mention that the whole of the fittings, when removed from the building, realised the sum of 25s.

The contractors for the electrical installation were Messrs. Tyler & Duncan, of No. 20, New Bridge Street, E.C.

The generating plant consists of a Crossley horizontal gas

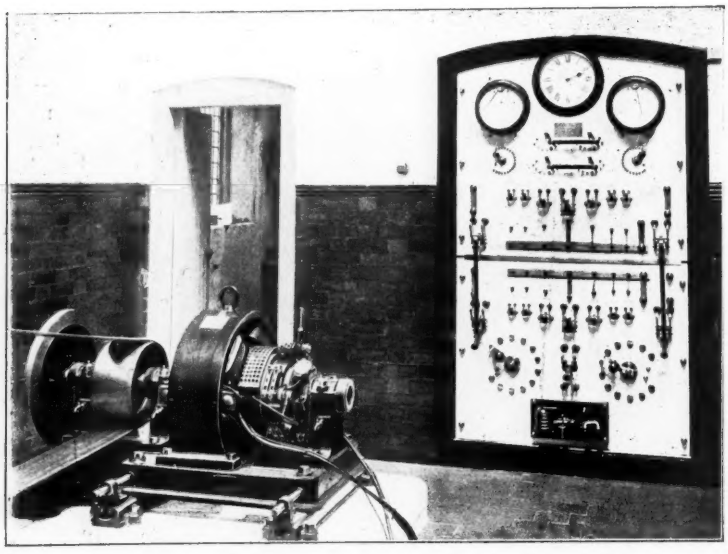


Warren House: The Library.

engine having a maximum output of 29·5 B H.P., at 250 r.p.m.; the engine is of the latest type, fitted with an extra

heavy fly-wheel and outside bearing, and drives the dynamo by belt. Three tanks are provided for the cooling water.

The dynamo was made by Messrs. Crompton & Co., Ltd., and is of their multipolar shunt-wound type, giving 100 amperes at 105 — 150 volts, 800 r.p.m.; views of the dynamo and engine are given herewith. Adjoining the dynamo is the main switchboard, which we also illustrate, consisting of two panels of white marble, fitted up with ammeters and voltmeters, charge and discharge battery regulators and various main and circuit switches. Provision is made for extending the plant and for charging motor-cars.



Warren House: Dynamo and Main Switchboard.

The battery consists of 56 cells, of Messrs. Pritchetts & Gold's manufacture, having a capacity of 85 amperes for 9 hours. A recording charge and discharge ammeter of Messrs. Elliott Bros'. make, and a Chamberlain & Hookham watt-hour meter, are provided.

The gas engine is started electrically with the aid of the battery, a special switch being fixed near the gas bag, as shown in the illustration, for this purpose; apart from the time taken to warm up the ignition tube—7 to 10 minutes—the engine can be started up and set to work in 30 seconds by this means.

The mains from the engine room to the house consist of Callender's lead-covered concentric cable, 37/16 gauge, carried in cast-iron pipes laid in trenches 2 ft. 6 in. below the ground level. From the main distribution board cables are laid to four distribution boards of the "Edinburgh" type, from which the lighting circuits are taken. A separate circuit supplies the stables. The wiring throughout has been carried out on the "looping" system in wood casing, and it is interesting to note that no joint exists in the whole of the installation.

Besides the ordinary lighting arrangements, an electric hot cupboard is installed, measuring 3 ft. 6 in. × 4 ft. 6 in.; electric kettles are also used in various parts of the house. We illustrate on the preceding page the interior of the library and drawing-room, showing rather the subject of the illumination than the means whereby it is effected; for, as in most cases where the lighting is properly carried out, the electrical fittings are exceedingly unobtrusive—at any rate, in the daytime!

CHEAP AND SATISFACTORY CONSTRUCTION.

By A. H. M.

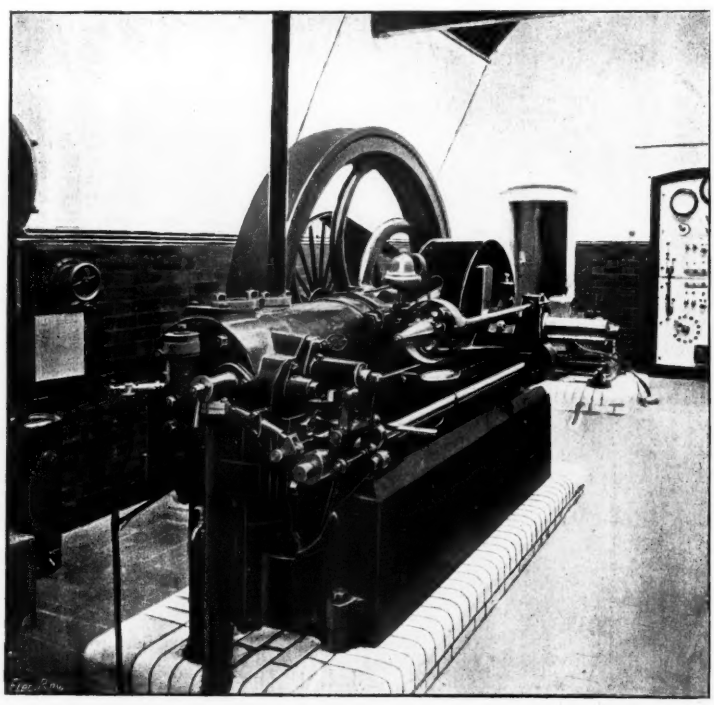
So keen and close has competition in the electrical manufacturing world become, that it behoves those who would avail themselves of the law which provides for the survival of the fittest to see to it that every possible economy, consistent with maintaining the efficiency of the article unimpaired, is taken advantage of.

In the construction of certain classes of switch work, there are directions in which economy may well be effected without lessening the working life, or affecting the satisfactory operation of the apparatus. For instance, take the case of a main installation switch, destined to be enclosed in a cast-iron case and finally fixed in some underground passage or cellar, and probably not brought into operation or even looked at once in a year. In the case of such a switch we often find that an article, expensive in construction, and as carefully finished as though intended for a main switchboard, is supplied and fixed.

As every manufacturer knows, finish represents a large proportion of the cost of such articles, but it would appear that this item is of very small advantage in apparatus intended for work of this nature.

Such brass castings as are employed might, instead of being accurately filed or shaped up and lacquered, be left in a less highly finished condition, and could be enamelled instead of going through the more expensive process of lacquering.

The contact-making arm is frequently an expensive affair of solid copper or brass, over which much time has been spent in filing, polishing and lacquering. Here, again, economy might easily be effected by making the arm itself from a soft iron casting, and the contact-making bridge from copper stampings, the iron arm being stove-enamelled.



Warren House: Gas Engine.

The above remarks will particularly apply to the largely used class of switches, fuses, circuit breakers, &c., required

for electric power installations, as such are, or should be, always enclosed in iron cases.

In the foregoing instances, the essential requirements are capacity for the work for which they are designed, and mechanical strength, the question of finish being so immaterial, that there is scope for a very large saving in manufacturing cost in that particular.

American manufacturing practice has always followed the lines indicated above; in fact, has, in many cases, carried the principle too far, that is to say, has not paused at the limit which cannot be exceeded without impairing the actual efficiency of the apparatus. Perhaps in no direction is flimsy construction so marked as in the foreign manufactured rheostat trade, where competition has finally evolved a type of article which can in many instances only be described as impossible, from an engineering point of view.

The liberal substitution of iron castings in place of brass or wrought parts is legitimate enough, but the character of the terminals, for instance, ought at least to bear *some* relation to the horse-power of the motor with which the switch is intended to be used, instead of, as is so frequently the case, consisting of a poor little device to which no man living can attach a cable.

In connection with the same class of apparatus there is, unfortunately, a very much more serious defect which cannot be overlooked, or, as it would possibly be more correct to say, which speedily brings itself to the notice of the unfortunate user. The writer refers to the resistance itself, which is, in order to save cost and space, cut down to the lowest limit as regards carrying capacity, with the inevitable result that the coils are constantly burning out and proving anything but economical to the user in the long run.

The above is a typical instance of cheap and *unsatisfactory* construction.

The writer was recently comparing some circuit breakers by different makers, and found in some manufacturers' work a marked tendency to cheapen construction by the adoption of well designed and neatly finished enamelled malleable iron castings in place of massive shaped and finished brass or gun-metal parts.

It will, of course, be understood that this applies only to such parts as are not required to carry current, brass or copper always being provided for that purpose.

Under no circumstances is the writer an advocate for cheap and flimsy construction, but, at the same time, he is convinced that there are many economies which may legitimately be effected, and of which the British manufacturer must avail himself, in order to be in the best position to check the inroads of foreign competition.

BUSINESS NOTES.

(*Continued from page* 462.)

Catalogues and Lists.—The approach of the arc lighting season has been signalised by the receipt of several lists relating to illumination and heating specialities. One of these is a priced circular of miniature arc lamps for shop and house lighting, issued by Mr. G. Braulik.

Messrs. D. Santoni & Co., Ltd, of 28, Ely Place, Holborn Circus, E.C., have just issued from the press a list (G) in which prices are given of "Supra" brush-holders, carbon copper brushes, foliated rolled metal dynamo brushes, and arc lamp carbons. A full description appears of a novelty which the firm is now offering for the first time, *i.e.*, a safety suspension lock for arc lamps. The illustrations show a sectional view of the device, and a lamp with it placed in position. It is made in two standard sizes, suitable for wire ropes measuring up to ¾ in. and 1½ in., respectively. The latter size type can be supplied combined with an automatic coupling arrangement, which makes and breaks the circuit when the lamp is raised or lowered, thus avoiding loose hanging wires. The apparatus is claimed to be quite simple and to afford absolute security against accidents.

Mr. H. Dudley Barlow, of 237, Shaftesbury Avenue, W.C., gives a few facts relating to his patent device for ensuring slow starting and stopping of lifts, hoists, &c, in harmonically graduated manner, irrespective of the speed of motor or prime driving shaft. It is claimed to obviate complicated controllers where electric lifts are used.

The Cambridge Scientific Instrument Co., Ltd., has issued an excellent and very useful list particularising the Duddell patent oscillographs. A very full description of the apparatus is accompanied by illustrations of the different types, the methods of working, and many copies of records taken with the oscillograph.

Messrs. Fuller, Macleod & Co. have issued a new list (Section T) in which prices and pictures are given of their telephones, switchboards and accessories. The illustrations of different types of telephonic apparatus are of a very high class and most effective in showing up details. Other sheets, issued separately, deal with the Lux incandescent lamps, lamp shades, small motors for fan and power work, and ceiling roses.

A new Jandus arc lamp price list has been issued by Messrs. Drake & Gorham, Ltd. Single and double enclosure types for continuous current are placed before the trade, of standard, commercial and spherical globe patterns. Lamps for alternating current circuits are likewise detailed, and prices of numerous spare parts are clearly set forth.

Books Received.—"Economic Notes on Insular Free Trade," by the Right Hon. Arthur J. Balfour, M.P. London: Longmans, Green & Co. 1903. 1s. net.

"Whittaker's Electrical Engineer's Pocket Book," edited by Kenelm Edgcumbe. London: Whittaker & Co. 3s. 6d. net.

"Electrical Installations," by Rankin Kennedy. Vol. V. London: The Caxton Publishing Co. 9s. net.

"Transactions of the North-East Coast Institution of Engineers and Shipbuilders." Vol. XIX., Nos. 8 and 9. Newcastle: The Secretary, N.E.C.I.E. and S.

"Science Abstracts," August 25th, 1903. (Parts A and B.) London: E. and F. N. Spon, Ltd. 1s. 6d. each.

"The Manufacture of Iron and Steel Tubes," by E. C. R. Marks. 2nd edition. Manchester: The Technical Publishing Co., Ltd. 1903. 5s. net.

"Governors and Governing Mechanism," by H. R. Hall. Manchester: The Technical Publishing Co., Ltd. 1903. 2s. 6d. net.

Dissolutions and Liquidations.—The *London Gazette* of 15th inst. contains notice of an application, which is to be heard on September 23rd at the Law Courts, for winding up G. F. Milnes and Co., Ltd., by the Court, or, in the alternative, for the continuance of the voluntary winding up under the supervision of the Court, and that Mr. H. H. Bloomer, chartered accountant, of Birmingham, or some other fit and proper person, may be appointed liquidator in the place of Max Meyer, the voluntary liquidator, or, in the alternative, to act jointly with him as liquidator. The petition has been presented by Messrs. John Lysaght, Ltd., of Bristol.

Messrs. F. A. Clayton and W. Turner (Clayton & Turner, electrolier makers and art metal workers, Manchester) have dissolved partnership. Mr. Clayton attends to debts and continues the business at the old addresses as Clayton & Co. Mr. Turner is to carry on business on his own account at 178, Stockport Road, Levenshulme.

Trade Announcements.—Owing to increase of business in the Birmingham district, the British Westinghouse Electric and Manufacturing Co. has had to establish a new district office in that locality, under the management of Mr. G. K. Chambers, formerly contract manager of the British Insulated Wire Co. The address of the new district office, which is now in full operation, is Central House, New Street, Birmingham.

Messrs. William Macdonald & Co. (Wm. Rickard's electric wires and cable suppliers) of 118, Queen Victoria Street, E.C., have formed their business into a limited company, with the title the British Electric Calibrated Fuses, Ltd.

Mr. Gwynne has retired from the business of Gwynne & Co., which he has conducted for the past 50 years at Brooke Street Works, Holborn, E.C., and Messrs. J. and H. Gwynne, Ltd., engineers, of Hammersmith Iron Works and 81, Cannon Street, have bought up his entire interest. They have taken over the staff, including Mr. Neville G. Gwynne, who has latterly managed the business. The business will be conducted at the Brooke Street and Cannon Street offices as heretofore.

The Berliner Telephone Manufacturing Co. has removed to larger premises at 200, Upper Thames Street, E.C., where a large stock will be carried, and most orders will be executed by return.

The Bristol premises of Messrs. Veritys, Ltd. have been removed from Edinburgh Chambers, Baldwin Street, Bristol, to 3, Queen's Square, Bristol, where they have taken extensive premises, stores, showrooms, &c., owing to increased business and for the better convenience of their customers in the West of England and Wales. By means of these alterations Messrs. Veritys are able to carry a larger stock for prompt deliveries.

Electric Lifts.—The Royal apartments used by H.M. the King last week at Doncaster racecourse have been furnished with an electric passenger lift by Messrs. Archibald Smith and Stevens. The machine is a duplicate of that erected for the King's personal use at Epsom by the same firm, and was during the King's visit under the care of Mr. Major on behalf of the makers and of the Doncaster Race Committee.

ELECTRIC LIGHT AND POWER NOTES.

Ayr.—The electricity department this year shows a surplus of £300. The number of consumers amounts to 681, an increase of 151 over the previous year. The number of lamps connected was 4,080 against 2,746. The total units consumed were 1,014,774. The revenue from private lighting at a charge of 5d. per unit was £4,864, an increase of £1,099; the revenue from public lighting at 2d. per unit was £3,547, an increase of £1,399. Traction and other sources of revenue brought the income to £10,611. Last year there was a deficit of £756. The salary of Mr. Roland Marshall electrical engineer, has been increased to £300.

Ballymena. — What could be more engaging in its artlessness than the action recorded below? The U.D.C. was asked by the B. of T. what steps it had taken to carry out its prov. order of 1897. In reply, the Council decided to ask the Board to extend the time of the order until the town had decided whether it would go in for electric light or not!

Bognor. — The U.D.C. has adopted the scheme put forward by the Industrial Engineering Co. for supplying electricity to the town.

Bo'ness.—The T.C. last week received a letter from Mr. Ogilvie, of King & Co., electrical engineers, Leith, in which he stated that he understood that they had agreed to appoint him consulting engineer. He now learned that the National Wiring Co. objected to his appointment, on the ground that he was a member of a firm of contractors. Had he been aware that they had a right to do so he would never have allowed his name to be considered at all, and he now withdrew his application. The withdrawal was accepted, and the Council appointed Messrs. Burstall & Monkhouse, London, as the Council's consulting engineers for the electrical scheme.

Brighton.—Mr. Arthur Wright, consulting engineer, has recommended the T.C. to charge for energy in the extended area 7d. per unit for 490 hours a year and 1d. afterwards. This will, he says, bring the average price to 4·3d. per unit.

Cambridge.—The University Library at Cambridge is to be lit by electricity. In view of the priceless nature of its contents, very special precautions are being taken to prevent any risk of fire, and Messrs. Handcock & Dykes, of Westminster, have been called in to advise on the subject. We understand that the contract has been let to the Cambridge Electric Supply Co.

Cheltenham.—In a discussion recently at the T.C. meeting, it was stated that the electricity undertaking had in eight years resulted in a loss of £17,000. The chairman of the Lighting Committee replied that this sum had not come out of the ratepayers' pockets; it was placed to a suspense account, and *was balanced by* £10,010 *in the sinking fund and another* £4,425 *awaiting investment.* He maintained that the undertaking had made a profit of £21,038 during the eight years. This kind of finance, we need hardly point out, is just the sort of thing that brings discredit on municipal management. The loss, of course, cannot be seriously denied; but to say that it is balanced by the sinking fund is as much as to say, "If I owe Tom a shilling and Dick another, I can pay them both, because I have a shilling in my pocket!" It would be far better for all parties, besides being the only honest course, to admit the loss, and to endeavour to remedy it, instead of juggling with figures in order to hoodwink the ratepayers.

Clydebank.—The T.C. has concurred in the plebiscite decision that the electric lighting of the burgh be carried out by the Clyde Valley Electricity Co.

Farnborough.—The U.D.C. has received an offer from the Farnham Gas Co. for the supply of the town with the electric light.

Horsham.—The U.D.C. has received from the L.G.B. sanction to raise a loan of £9,500 for E.L. extension purposes. There are now 4,275 lamps connected, and applications for 1,5 more have been made.

Huddersfield.—A deputation has waited on the Electricity Committee of the T.C. with a view to the extension of the electricity mains to the township of Golcar. The deputation decided to recommend the District Council to approve similar terms to those arranged between the Corporation and the Linthwaite Council, subject to the mains being laid in the principal streets within two years from the commencement of the order.

London.—Battersea.—We understand that the paragraph published in our last issue, relating to trouble with the Borough Council's employés, was without foundation in fact, and we have pleasure in making this correction.

Shoreditch.—The estimates submitted to the B.C. on Tuesday provided for working expenditure to the amount of £21,769 for the electricity undertaking during the six months to end March 31st, 1904. This makes the total estimated expenditure for the year £44,056. It was stated that the estimated surplus was £1,751. Sanction was given for capital expenditure of £1,350 to provide additional store accommodation in Coronet Street, and £350 for running a larger main along Wilson Street. The Lighting Committee reported that the last-named expenditure was necessary to comply with an application for a supply of current amounting to 500 amperes, from which a yearly revenue of £500 would be received.

Bermondsey.—On Tuesday the B.C. considered a long report from Messrs. Kincaid, Waller, Manville & Dawson upon proposed extensions to the electric undertaking. They recommended that the following plant be installed at once:—Engine house:—One 300-kw. dynamo of 480—500 volts, direct coupled to a high-speed three-crank triple-expansion engine, with proportion of spares, £2,900; engine and generator foundations, £220; additions to main switchboard: one generator panel, three feeder panels, two booster panels, cable connections, £690; two booster transformers for outside district feeders, £800. Destructor house:—One additional boiler of the same size as the existing boilers; two additional destructor cells, overhead storage tank for artesian well water, extension of destructor house building — in all, £5,510. Low pressure feeders and distributing mains for the supply at Rotherhithe, £11,078; 35 arc lamps, with mains, switch pillars, &c., £1,761; engineering and contingencies, £2,295; total, £25,254. Further plant to be installed when extensions to buildings are completed:—Engine house:—One 300-kw. 500-volt dynamo, direct coupled to high-speed triple-expansion engine, £2,900; additional balancer, £300; further additional switchgear; one generator panel, cable connections, balancer panels, £400; extension of engine house to receive above set and space for two further sets, including engine foundations, £3,450. Boiler house:—Two boilers of the water-tube marine type, each to evaporate normally 11,000 lbs. of water per hour with steady steaming, and 14,000 lbs. if requisite, complete with fittings, £2,400; new boiler house building, £4,282; foundations for two new boilers, £100; economisers for two new boilers, £400; superheaters, £240; chain grate stokers, £440; main flue and up-takes with connection to existing underground flues, £500; induced draught apparatus, consisting of motor-driven fan and connections to flue, £400; extensions to steam, exhaust, feed and drain pipes, additional feed pumps and connections, £800; coal conveyor and elevator, with receiving hopper and electric driving gear, £900; coal bunkers to serve four boilers (two boilers only being installed at present), providing storage for 200 tons of coal, £1,000. Wiring of building extensions, including offices, £350; booster transformer rooms, stores and offices over same, £1,590; extension of engineer's offices, £533; incidental works, £750; add 10 per cent. for engineering and contingencies, £2,173; total, £23,908. Mr. Cox, chairman of the Lighting Committee, explained that the scheme differed in several respects from that previously prepared by Mr. Vincent and Mr. Angel, that the proposed sub-station at Rotherhithe would be done away with, and that the total cost would be smaller than in the first scheme. It was decided to carry out the extensions in accordance with the report of the consulting engineers, who were retained at an inclusive fee of 2½ per cent. Messrs. Kincaid, Waller, Manville & Dawson reported that notwithstanding the hardness of the water from the artesian well, the purifier supplied by the Stanhope Co. had proved to be capable of dealing with it in a thoroughly efficient manner. There was therefore no reason now why the water should not be used regularly in the boilers.

Maidstone.—The Corporation Electricity Committee on Friday recommended the T.C. to apply for a loan of £1,770, the sum necessary to adapt the machinery at the electricity works to traction purposes.

Queenborough. — The reconstruction of the Flushing Pier at Queensborough, in the Isle of Sheppey, destroyed by fire some years ago, and belonging to the South-Eastern and Chatham Railway Co., is fast approaching completion. The whole of the gigantic structure is now electrically equipped throughout, all the cranes, capstans, &c., being driven by electricity from the new power station erected on the plant. For lighting the pier there are eight arc lamps of 2,000 c.p. each, and about 200 incandescent lamps. The installation is worked on the two-wire system, supplying continuous current, at a pressure of 230 volts. The generating plant consists of two Electric Construction Co.'s direct driven steam sets (Willans), each capable of giving an output of 60 h.p. when running at a speed of 460 revolutions per minute, and the engines are of the central valve compound type, suitable for working condensing or non-condensing, as required, with a pressure of 150 lbs. per sq. in., and also capable of giving 90 b.h.p. continuously. The generators are of the E.C.C. standard bipolar type, shunt wound, and suitable for supplying power direct or charging batteries. The boilers are two in number, of the Lancashire type, suitable for working at a steam pressure of 150 lbs. per sq. in., or 180 lbs. if required. Each boiler is of sufficient capacity for working both engines, and natural draught is employed. There are also included the necessary feed pumps, injectors, and condensing plant. The battery forms a reserve, which may be drawn upon in heavy loads, and works in conjunction with a Highfield patent booster (the E.C.C. are the sole makers), by reason of which steadiness of the electrical pressure is maintained should the load be suddenly increased or diminished. The main switchboard is mounted in a polished wood frame, and is made of enamelled slate, upon which are mounted the necessary instruments and switching apparatus. It is divided into four panels, two for the generator circuits, one for the power and lighting circuit, and one for the battery and boosting circuit. It may be added that all horse labour on the pier has been supplanted by the new motive power. Mr. S. Jones is the company's engineer-in-charge.

Southend.—Last week a L.G.B. inquiry was held into the application of the Corporation for sanction to borrow £20,000 for the purpose of increasing the plant at the electrical works and extending the mains, these developments being necessary through the demand for lighting. The number of lamps that had been connected up to the present was 28,000, and the figures up to March 31st last, when the financial year ended, showed a working expenditure since October of £4,318 19s, while the income had been £5,214 15s. 9d, leaving a gross profit of £895 16s. 9d. As the repayment of loan and interest amounted to £1,889 7s. 3d., there was a net deficiency of £993.

Teddington.—The U.D.C. has accepted the offer of the Twickenham and Teddington Electric Supply Co. to light 12 lamps by electricity, free of cost, as an experiment, and in order to compare electric lighting with gas lighting.

Walton-le-Dale.—The U.D.C. has decided to take steps to obtain a prov. order for electric lighting. A company has already given notice of its intention to apply for powers to supply the district.

Walton (Surrey).—The D.C., after considering an offer from the Weybridge Urban Electric Supply Co. to light the district, referred the whole question of the policy to be adopted, in regard to the prov. order recently obtained, to a committee.

Whitehaven.—The L.G.B. has sanctioned the raising of a loan of £2,500 for electric lighting purposes.

The Corporation has offered to light the harbour with electricity on terms ranging between £355 and £432 per annum, according to the kind of lamps used.

Windsor.—The T.C. has appointed a special committee to consider whether the future lighting shall be by gas or electricity.

ELECTRIC TRACTION NOTES.

Aberdeen.—At the half-yearly meeting of the Great North of Scotland Railway Co., Mr. Ferguson, the chairman, said that the competition of the electric tramways in the neighbourhood of Aberdeen had cut into the receipts of suburban trains, and the projected new trams towards Donside, on the one hand, and up Deeside on the other, were sure to prove a further serious rival. With a view to meeting this, the directors were seriously considering whether they could not adopt some description of motor-carriage, as was now being experimented with on the London and South-Western and the London, Brighton and South Coast Railways.

Aston Manor.—The T.C. has accepted Mr. George Trentham's (Birmingham) estimate of £32,500 for the permanent way work for the new electrical trams. The contract covers the routes from the Birmingham boundary, and includes Aston Road, Aston Road North, Lichfield Road and Victoria Road—all double track, with the exception of a short single line below the railway bridge at Aston Station. All the material used must be of British manufacture. The question as to whether single or double track can be used in Park Road has been referred to the B. of T. for settlement, as the road in question, if the roadway of 30 ft. 4 in. is allowed, will necessitate the footpath being reduced to 6 ft. At the same meeting the clerk was authorised to negotiate loans as follows:—Purchase of tramways, £70,000; for permanent way contract, £32,500; overhead work, £10,000; electricity supply station, £62,000. The supply station was informally opened this week.

Ayr.—The past year's working of the Corporation Tramways shows the total number of passengers carried to be 3,201,586, and the revenue £13,775. The average fare per passenger was 1·03d., and the average drawings per car-mile 9·85d. After allowing for depreciation and sinking fund there is a surplus of £1,538 for the year. The capital spent to date amounts to £74,220.

Bromley.—At the last meeting of the R.D.C. a letter was read from Edmundson's Electricity Corporation, offering to formulate a new tramway scheme. No action was taken on the communication.

Kirkcaldy.—The extension of the tramways route is approaching completion, and it is anticipated that the whole system will be completed by the end of November.

London.—Camberwell.—The B.C. has received a communication from the Board of Trade stating they have approved of the plans of the L.C.C. for the reconstruction and construction, on the underground conduit system, of the following tramways:—(*a*) from Camberwell Green *viâ* Denmark Hill, Champion Park, Grove Lane, Dog Kennel Hill, Grove Vale and Lordship Lane to near the junction of that thoroughfare with Crystal Palace Road, (*b*) at Denmark Hill connecting the above tramway with the existing tramway in Coldharbour Lane.

Manchester.—The completion of the municipal tramway system is having a damaging effect on cab and omnibus business in Manchester. All the main thoroughfares of the city are now served with cars, which the public find enables them to get from place to place as expeditiously as by cab hire, and at very much less cost. The casual omnibus and wagonette service, which formerly served a useful purpose, has now practically disappeared. In the year ending June, 1901, 762 cab licenses were issued, in the following year 677, and in June last 576. These reduced figures are accounted for by the decreased use of the cabs by the public since the opening of the tramways.

Salford.—The tramways report just issued for the year ending March last shows that during the 12 months a gross surplus was made of £39,856, out of which the Committee find it possible to appropriate £10,000 as a contribution in relief of the rates. During the year 16 miles of single track were added to the system, which practically completes the reconstruction scheme authorised by Parliament. In all, the cars run over 35 miles of track in the borough, and 8½ miles outside its boundaries. During the period covered by the report over 28,000,000 passengers were carried, the receipts being £144,486 odd, and the mileage run 3,380,590. The highest receipts in one week were £3,632; that was in Whitsun-week. The total working expenditure amounted to £104,969, of which £27,384 was for electric current, supplied at 2d. per unit, less 2½ per cent. The running of the cars has been attended with some few accidents; the fatalities during the past year numbered seven. The electric energy expended for haulage, lighting, &c., was 3,370,434 units, for which 2d. per unit, less 2½ per cent., was charged by the Electricity Committee. The Tramways Committee congratulate themselves on being able to show so satisfactory a profit, considering that the receipts cover a period when a large part of the track was in process of reconstruction. There is every reason to expect much better results next year.

Sunderland.—At a meeting of the T.C. on the 9th inst. the Tramways Committee reported that they had had a letter from the Whitburn Parish Council asking for an extension of the tramways to that parish, but, after having had a report from the electrical and tramways engineers, they recommended that in view of the cost of such an extension it be not proceeded with at present. It may be mentioned that Whitburn is a fishing village north of Sunderland, and on the route of the proposed line by the B.E.T. Co. in their South Shields and Sunderland light railway scheme, the Bill for which has been twice rejected by Parliament. There is no railway within 2½ miles. The Committee proposed that a provisional order be obtained for authority to construct (*a*) a single line of tramway from Harbour View along new Roker Park Road South, and St. George's Terrace to Roker Terrace; (*b*) a single line of tramway from Bridge Street along West Wear Street, Bedford Street, and High Street West to the south end of Bridge Street, subject to a satisfactory arrangement being arrived at with the owners of the property at the north-west corner of West Wear Street. The chairman (Mr. Summerbell) said in respect to the Whitburn line they had gone into the question of going even as far as Whitburn Bents (about two-thirds of the whole distance), and they found that that portion would cost 1s. 3d. per car-mile, and there was no prospect of such a return in both winter and summer. They did not abandon the idea of laying a line there ultimately to the loop lines suggested; these were proposed so as to facilitate traffic, and that at Roker was estimated to cost £2,300, and that at Bridge Street £1,600. Both would obviate the present necessity of stopping and changing the trolleys, and that at Bridge Street would clear the lines to some extent of standing cars, and expedite regular traffic. The Committee's recommendations were, after some discussion, carried.

Wednesbury.—It is expected that the electrification of the portion of the tramway system between the White Horse Hotel and Holloway Bank—about which length there has been considerable negotiation between the Corporation and the South Staffordshire (Lessee) Co.—will be completed in a month's time.

Wolverhampton.—The tramway muddle has within the past week assumed quite a new phase, and there has been a signal triumph for the advocates of the Lorain system of traction. It was known at the beginning of last week that the Lorain Co. had intimated to the Corporation that they were not prepared to make any concessions, that they claimed to have fulfilled their contract, that they were entitled to the sum they had expended on the track, and that if the money were not immediately forthcoming, then the Corporation and the company must proceed to arbitration. A meeting of the Tramways Committee was held on Thursday afternoon in last week, when the sub-committee—consisting of four members of the Council, wholly in sympathy with the Lorain Co., and who had been conducting the negotiations—reported the result of their labours, from which it appeared that the Corporation had offered the company £15,000 for the existing tramway. The offer was rejected, and fresh proposals were then made, but these met with a similar fate. The final communication of the company took the form of an imperative demand for the payment of the whole sum expended by them, nearly £25,000, by Tuesday in this week. Failing this the company intimated their intention of proceeding immediately to arbitration. The sub-committee, therefore, proposed that the Tramways Committee should recommend the Council to take over the existing tramways on the company's terms. They pointed out that the company were willing to reinstate a portion of the existing boxes with an improved mechanism, but several members appeared to be surprised that the company were not ready to attend to the whole of the boxes. Furthermore, emphasis was laid on the fact that the new boxes had had no practical test, and that their virtue was, after all, doubtful. Great stress was again laid upon the heavy cost of the Lorain system as compared with the overhead. The result of the discussion which took place was that the proposal of the sub-committee was defeated by six votes to five. On the question of submitting a report to the Council, five members of the Committee voted in favour of, and five against, the proposal, one remaining neutral, as he could not see any good in such a report.

The meeting of the Committee was, of course, held with doors closed to the representatives of the Press, as was also a special meeting of the Town Council convened for the following (Friday) afternoon. Indeed, with one or two exceptions—these being unavoidable—all the meetings of the Committee and of the Council at which the tramway trouble has been debated, have been in the absence of representatives of the Press, who are not vouchsafed any information whatever. When, therefore, the Council met in private on Friday there was no report from the Tramway Committee, the members had only the knowledge that the majority of the Tramways Committee were opposed to payment and in favour of going to arbitration, which, indeed, was the attitude taken up by the decision of the whole Council on May 20th, after several days' debate. The decision then arrived at, on the motion of Councillor Ernest White, was that the company be called upon to take up the track or proceed to arbitration. That decision has never been rescinded. This was the position of affairs when the Council met on Friday. It is stated that, at the outset of the deliberations, Alderman Mander, as chairman of the Tramways Committee, was invited by the Mayor to make a statement to the Council. The worthy Alderman then proceeded to state what the exact nature of the last offer of the Lorain Co. amounted to. It had been generally rumoured, he said, that the

terms which the company put forward were that the Tramways Committee should hand over, not later than Tuesday, September 15th, a sum down in hard cash of £25,000, or, in the alternative, submit to have the running of the trams stopped, and the questions in dispute submitted to arbitration. This, however, was not correct, for the terms first demanded were a cash payment of £25,000. Against this the Committee offered £15,000, which the company refused to accept. But, after further negotiations, they had been induced to some extent to give way by reducing their demand for a cash payment to £22,000, and they, on their part, would hand over to the Tramways Committee 6,000 new electric boxes, with an improved mechanism, in exchange for the same number of boxes now in stock or in use, 1,000 only if the new boxes were, however, to be laid down at the company's expense.

Alderman Mander then presented a number of figures in favour of the acceptance of the company's offer, and he claimed that the laying down of the improved boxes would reduce the cost of maintenance of the present tramway system by £530 per annum. The figures, however, were strongly combatted by the opponents of the Lorain system; whilst supporters of the company warned the Council against being forced to go into arbitration, as the result might be damaging to the interests of the town and entail upon the Corporation considerable additional expense, even if successful. After a prolonged and irregular discussion, a resolution in favour of the company's offer being accepted, was carried by a majority of 23 to 15. Ten members of the Council were absent.

It is stated that Alderman Mander and the vice-chairman of the Committee (Alderman Craddock) endeavoured to prove that during the last four months, by cutting down the expenditure, they had made a greater profit on the trams than had ever previously been the case. Mr. Shawfield, the electrical engineer, however, demurred to this statement. If he did not flatly contradict it, he did not find himself in perfect accord with the advocates of the Lorain system, but significantly adhered to the figures contained in his report, and did not retreat a single inch from the position he had taken up.

The above resolution has to be confirmed at another special meeting of the Council, and in the presence of the representatives of the Press.

The question was accordingly raised as to whether at the special meeting open discussion would be allowed. It was pointed out by those who spoke in support of this course that it would be unfair to the several members now absent on holiday and from other causes to allow so important a resolution to be confirmed without their having had the opportunity of expressing their opinions thereon. Further than this, the public outside, who were largely interested and divided in opinion on the question, were entitled to have their minds enlightened as to the reasons which had influenced the majority in the Council in coming to the decision for taking over the system. It was suggested that the speeches might be limited in duration, and Councillor Evan Evans proposed that open debate should be permitted with a limit of five minutes to each speaker. This, however, was strongly opposed by the Lorain party. The town clerk strongly objected to further discussion, and stated that during the whole of his 20 years' experience as town clerk he could not remember a single occasion on which a subject that had been debated and decided upon by the Council in committee had been re-opened for discussion at any subsequent meeting. The only legal course was to formally put the confirming resolution to the vote without debate. Against this, it was urged that the question had been discussed in open Council on previous occasions, and there was no reason why it should not be briefly debated again, with the Press present, before coming to a final settlement. As one member jocularly remarked, "The next special meeting is to be an open one, with the members of the Council muzzled." Ultimately the meeting broke up in confusion.

It may be added that the sub-committee who have been conducting the negotiations claim that the Lorain Co. have made a concession to the Corporation in handing over some 6,000 new boxes; that, in fact, a saving of £533 per annum is effected. But it will be remembered that Alderman Mander, at a recent meeting of the Council, proposed a resolution calling upon the company to renew the whole of the boxes and put them into good order before the Corporation would accept the system. That resolution was rejected in May, and Councillor White's amendment carried, yet those who voted against Alderman Mander on that occasion have now voted for a bargain which to many may not seem as good. Many of them on that occasion said they could not consent to the Lorain system being adopted unless much better terms than those in the resolution were offered.

TELEGRAPH AND TELEPHONE NOTES.

Atlantic Cables in War Time.—The *Times* reports that Major Bland, of the Royal Engineers, was at St. Johns on 8th inst., completing his inquiry into the question of defending, in time of war, the Atlantic cables crossing the Grand Banks.

Postal Telegraphists.—A large meeting of Post and Telegraph officials was held on Thursday, September 9th, at the Bull's Head Hotel, Leicester. The chair was occupied by Mr. W. C. Steadman, L.C.C., who said they had succeeded, to a limited extent, in getting the present Postmaster-General to appoint a committee of what he termed experts. It was not to be supposed that they were satisfied with the composition of that committee. However, after all, by the appointment of that committee they had secured a great victory, and that was in the breaking down of the finality of the Tweedmouth Committee. That was assured, whatever became of the inquiry. Should the recommendations of the Post Office Committee be unsatisfactory, by giving evidence, the employés would strengthen their position 10 times over for further agitation. The Government derived a profit of between £3,000,000 and £4,000,000 per annum out of the labour of the postal staffs, and the latter had, therefore, a right to demand more than they were receiving. Mr. E. Lea, of Manchester, general secretary of the U.K.P.C.A., spoke in the advocacy of organisation, federation, and representation. Mr. Charles H. Garland, of London, entered a protest against the appointment of a bogus committee. Mr. G. H. Stuart, postal candidate for York, addressed the gathering on Post Office matters. Mr. Cheeseman, of the Fawcett Association, London, spoke on postal politics, and was followed by Mr. Burt, of Bristol.

The Telegraph Wire Export Trade.—The export trade of this country in telegraph wire and apparatus connected therewith continues relatively very quiet, the shipments last month only attaining a value of £62,272 as compared with £391,207 in the corresponding month of last month, and £900,358 in August, 1901. The quietness is also reflected in the returns for the eight months ending with August last, the shipments during which period only amounted to £1,528,466 as contrasted with £2,175,993 in the corresponding eight months of 1902.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
Latakia-Cyprus	June 20, 1899	
Trinidad-Demerara No. 1	Aug. 27, 1901	
Trinidad-Demerara No. 2	Aug. 26, 1903	Sept. 14.
Dominica-Martinique	May 8, 1902	
St. Lucia-Martinique	May 8, 1902	
Guadeloupe-Martinique	May 9, 1902	
Martinique-Puerto Plata	July 10, 1902	
Cayenne-Pinheiro	Aug. 13, 1902	
St. Lucia-St. Vincent	Sept. 19, 1902	
Reissa-Issa	Oct. 22, 1902	
Reissa-Yemani	Oct. 22, 1902	
Paramaribo-Cayenne	Feb. 27, 1903	
New York-Haiti	April 13, 1903	
Bolama-Bissao	Aug. 4, 1903	
Antigua-Guadeloupe	Aug. 9, 1903	
Corea-Seoul-Genzan	July 30, 1903	
Delay to Nassau, Bahamas	Sept. 14, 1903	
Landlines.		
To Puerto Barrios	July 28, 1903	
Rome-Pera	Aug. 7, 1903	Sept 14

CONTRACTS OPEN AND CLOSED.

OPEN.

Belgium.—October 3rd. The Municipal Authorities of Liège are inviting tenders until October 3rd for the supply of six electric tramcars. Particulars may be obtained from, and tenders are to be sent to, Le Bureau Administratif des Travaux, à l'Annexe de l'Hotel de Ville, Liège.

Bermondsey.—September 21st. Dust destructor plant, 300-kw. steam generators, feeder boosters, motor balancer, switchgear, cables, &c. See "Official Notices" September 4th.

Blackpool.—The Corporation wants tenders for a year's supply of arc lamp carbons. See "Official Notices" to-day.

Brighton.—October 5th. Steel rails, tramcars, points and crossings for the Corporation tramways extensions. See "Official Notices" September 11th.

Brisbane.—September 30th. The Deputy Postmaster-General is in the market for certain postal and telegraphic material.

Cuba.—September 28th. Tenders are being invited until September 28th by the municipal authorities of Cienfugos for the concession for the electric lighting of the public streets and buildings of the town.

France.—October 1st. The French Post and Telegraph authorities in Paris are inviting tenders until October 1st, for the supply of a large quantity of paper-insulated electric cables. Particulars may be obtained from, and tenders are to be sent to, Le Sous Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle 103, Paris.

Holland.—October 1st. Tenders are being invited by the municipal authorities of Utrecht for the construction and equipment of a central electricity station for lighting and power purposes, and for the working of a tramway.

Johannesburg.—September 21st. 70 10-amp., 40 25-amp., 10 50-amp. electricity meters. See "Official Notices" September 11th.

Johannesburg.—October 5th. A large quantity of steel rails, fishplates, tie-bars, &c., for the Corporation tramways. See "Official Notices" September 11th.

Johannesburg.—November 16th. Gas producer plant; gas engines and dynamos. Alternative:—Water-tube boilers, steam engines or turbines, electric generators, and other plant. For the municipal tramways and electrical supply scheme. See "Official Notices" August 28th.

Launceston (Tasmania).—September 28th. 500 or more electric meters. See "Official Notices" June 12th.

London.—October 6th. Four 5,000-H.P. vertical-horizontal steam engines, each suitable for driving a three-phase generator, for the Greenwich power station. See "Official Notices" July 24th.

Portugal.—October 21st. Tenders are being invited until October 21st by the Portuguese Ministry of the Colonies in Lisbon for the concession for the electric lighting of the town of Macao in the Portuguese Colonies.

Manchester.—October 1st. 1,200 electricity meters. See "Official Notices" to-day.

Rochdale.—September 26th. Electrical work at the Dearnley Workhouse. See "Official Notices" September 4th.

Roumania.—October 10th. Tenders are being invited until October 10th by the Roumanian State Railway Authorities in Bucharest, for the installation of a complete electric lighting plant at the railway works in that city.

Salford.—September 19th. High-tension cable. See "Official Notices" September 4th.

Sheffield.—October 8th. 25 double-deck cars with trucks and equipments. See "Official Notices" to-day.

Sweden.—October 15th. Tenders are being invited by the municipal authorities of Gelfe until October 15th for the supply of six electrical cranes.

CLOSED.

Aldershot.—A contract has been placed with the Sir Hiram Maxim Electrical and Engineering Co., Ltd., by the War Office, for high voltage lamps for use at Aldershot.

Cheadle and Gatley.—The Tramway Committee of the U.D.C. has accepted the tender of Messrs. Briscoe & Sons, Stockport, for laying the permanent way of the electric tramway from Cheadle Bridge to Gatley, at £10,248 1s. 8d.

France.—The French Post and Telegraph authorities have just placed contracts with the Compagnie Francaise du Bimetal, of Paris, for 60 tons of bimetallic wire, 2 mm. dia., and 40 tons ditto 3 mm. dia., at 1,742½ fr. per ton.

Glasgow.—The T.C. has accepted the offer of the Brockie-Pell Arc Lamp, Ltd., for 55 arc lamps, at a cost of £5 18s. 6d. each.

Grimsby.—The Lighting Committee has accepted the following tenders in connection with the underground sub-station to be built at Riby Square:—Electrical plant, Siemens Bros. & Co., £354; Lancashire boilers with automatic stokers, Underfeed Automatic Stoking Co., £1,013; switchboard work, Kelvin and J. White.

King's Norton.—Messrs. R. W. Blackwell & Co., Ltd., have secured the contract for the permanent way and bonding for the new electric tramways for the King's Norton and Northfield Urban District Council, for the sum of £16,892. British material only to be used.

Maidstone.—The Electricity Committee recommends the T.C. to accept the tender of Messrs. Davey, Paxman & Co. for a 150-KW. dynamo at £1,327, the firm taking the present one of 75 KW. in exchange.

Rugby.—Mr. E. M. Redfern, of Birmingham, has obtained the contracts for electric lighting; mains and wiring for experimental work; motor generator; and system of inter-communication telephones, for the Chemical School, Rugby.

South America.—Messrs. Mather & Platt, Ltd., have received a contract to supply a complete electrical power and lighting plant for shipment to South America, comprising three combined sets of engine and dynamo, each of a capacity of 200 KW., and two sets of 60-KW. each, with two surface condensing plants, provided with motor-driven circulating and air pumps, and each capable of dealing with 12,000 lbs. of steam per hour. The generating plant will furnish power to 45 continuous current motors, varying from 1½ B.H.P. to 42 B.H.P., five of these being direct-coupled to centrifugal pumps, and two to the condenser pumps. Messrs. Mather & Platt have also recently received a contract for a complete three-phase power plant for a cotton mill. The direct-coupled three-phase generator runs at 330 revolutions per minute, and gives an output of 550 KW. with a frequency of 50 cycles per second at 440 volts. There are 23 induction motors, the great majority of which are of 25 B.H.P.

Sunderland.—At the T.C. meeting on the 9th inst., it was decided to place an order with the Chatterls Engineering Co., for a travelling crane for the Pallion sub-station.

Walsall.—The T.C. has accepted the tender of the Electrical Power Storage Co., Ltd., for supplying and erecting a battery for the Butts Road sub-station, at a cost of £1,062.

FORTHCOMING EVENTS.

Saturday, September 19th.—At 3 p.m. Civil and Mechanical Engineers' Society. Visit to the generating station of the L.C.C. South London Tramways at Tooting.

Monday, September 28th.—At 8 p.m. Institute of Marine Engineers. Mr. A. E. Mills on "Water-tube Boilers" (adjourned discussion).

Wednesday, October 14th.—At 6.45 p.m. Institute of Marine Engineers. Annual Dinner at Great Eastern Station Hotel, E.C.

NOTES.

Municipal Trading.—A member of the Plymouth T.C., writing to the *Times*, points out that in some cases municipal works carried out with borrowed capital "have worn out or become obsolete long before the period allowed for repayment has expired. In his evidence before the House of Commons Select Committee of 1902 on the repayment of loans by local authorities, Mr. Kershaw, of the Local Government Board, furnished no less than 29 instances, occurring within about five weeks in the ordinary course of business of his department, where works, or some portion of them, failed to last for the period allowed for repayment.

"The Plymouth Corporation electric tramways afford local ratepayers a home-made illustration of the same tendency. This year the Council has been warned by its expert officials that the track and equipment of all the sections of the undertaking will require reconstruction at varying periods within the next 12 years at a total cost of over £30,000. Two of these sections, built in 1896 and 1901 respectively, will require reconstruction as early as 1908 at a cost of £8,900 and £9,000 respectively. The existing loans raised for the original construction will not be paid off for the most part until 1930 and 1931. Not a penny has been set aside for depreciation or reserve; indeed for the year ended March 31st last the revenue accounts show a loss, in addition to an accumulated deficit of £5,000.

"The auditor foreshadowed in the Joint Committee's report would no doubt call the attention of the Local Government Board to this serious state of the tramways finances; but, as in the cases referred to by 'Civilian,' it is difficult to see what that department could do beyond censuring the Council, or how such censure of their representatives could help the long-suffering ratepayers from being called on to pay up for the past neglect or mismanagement so censured.

"A remedy which would, I submit, be worth trial as a preventive lies in the direction indicated in one of the recommendations of the Repayment of Loans Committee. Let Parliament or the Government Department to whom a municipality has to apply for sanction to raise a loan for a given undertaking require, as a *sine qud non* of such sanction, that the municipality shall year by year set aside out of the revenue of the undertaking, or, if need be, from the rates, a specified sum by way of depreciation or reserve in addition to the ordinary charges for the service of the debt. Let the Local Government Board be empowered to satisfy themselves, by means of annual returns furnished by the corporation and properly verified, such as are now required in the case of sinking fund payments, that the necessary amount is being duly set aside, and not at any time withdrawn from the proper fund without the Board's sanction. Let there be the same penalties attached to both incorrect returns and improper dealings with the funds in question as at present safeguard municipal sinking funds from being tampered with."

We have great hopes that, as in this case, the principles of sound finance for which we have so long contended will ultimately be recognised, and that they will be rigidly enforced.

Curious Fatalities.—An accident, the actual cause of which is as yet unexplained, occurred at the Shawhead Pit of the Rosehall Coal Co. on the afternoon of the 11th inst. While three

men were walking in Indian file from the Kiltonque seam, two of them fell to the ground with a shriek, and the third, upon turning round to see what was the matter, received a shock "as from a powerful battery." After recovering from the effects, he found that both of his companions were dead. It is reported that three men in another level of the same pit also received slight shocks. Electric lighting is employed in certain parts of the workings, but the report has it that Kiltonque seam has no electric cable whatever. No doubt the inquest will throw some further light on the affair.

Magnetic Disturbances.—A Reuter telegram from New York says that Prof. S. J. Barnett, of Stamford University, who has been investigating certain magnetic disturbances on the Alaskan coast, which render navigation difficult, has found an abundance of magnetic rock in the vicinity of Skagway and Douglas Island, which almost makes a local magnetic pole at that point.

An Electric Lamp Syndicate: a European Combination to Increase Prices.—It is stated that the negotiations have so far proceeded that the formation of a syndicate of makers of incandescent electric lamps in Europe is now regarded in trade circles as being assured. The negotiations on the subject have been in progress for a long time past, but the difficulties which have arisen in apportioning the production of each manufacturing company have hitherto prevented the scheme from being brought to a successful issue. The *Neue Freie Presse*, of Vienna, states that the output of the works proposing to form the syndicate amounted to 27,500,000 lamps last year, and it is on the basis of this production that the constitution of the combination is projected. Among the German, Austrian and other works interested in the question, are the Berlin General Electricity Co., which alone turned out 5,000,000 lamps in 1902, the United Electricity Co., of Vienna, which sold 4,000,000 lamps last year, the Siemens & Halske Co., of Berlin, Sturm & Co., of Vienna, and other factories.

The principal obstacle in the way of the formation of the syndicate originally lay with the Berlin General Electricity Co., with the largest sale in Europe, and whose production far exceeds that of the Siemens & Halske Co. As, however, the former has now adopted a conciliatory attitude, and has agreed to accept the same apportionment as the latter company, the difficulty as between these principal German companies has been overcome. If the syndicate is brought into existence, it will be for a period of 10 years, and it is intended to fix minimum prices both for wholesale business and retail trade, the prices to be considerably higher than those at present in force, which, in most cases, are said to result in a loss at the present time.

India-Rubber in New Guinea.—The Colonial Economic Committee of Berlin announces that the utility of the gutta-percha discovered by the expedition which was undertaken to New Guinea under the leadership of Herr Schlechter, the india-rubber expert, has so far been established that the gutta-percha from the low-lying country is suitable for cable purposes as an admixture, whilst if carefully won it is probable that it will also be fit for cables in a pure condition. Herr Schlechter states that the quality of the gutta-percha from the high-lying country—the Finisterre and Bismarck Mountains—is superior to that obtained in the low lands.

The Felten & Guilleaume Cable Works Co., the Siemens & Halske Co., and the North German Sea Cable Works Co. have received large quantities of gutta-percha from New Guinea, and are at present engaged on the testing of the material, which extends over a considerable period. In this connection, it is to be noted that the Secretary of State for the Imperial Post Office has granted a large sum of money to allow of the testing being carried out at the works. The Colonial Economic Committee, having regard to the importance of the question, now proposes to establish a gutta-percha enterprise for the education of the native population of New Guinea in the cultivation of gutta-percha and its winning. This will take the form of a fresh expedition under Herr Schlechter for a period of three years, and will be assisted by natives of Borneo and others familiar with the question of rubber production.

Appointments Vacant.—Mains superintendent for Plymouth (£143); shift engineer for Taunton (£100). The London County Council is inviting applications for the post of chief officer of tramways, at £1,500; applications have to be lodged by September 28th. Assistant engineer for Hampstead electricity works (£150); assistant resident engineer for Middlesex Hospital. See our advertisement columns to-day.

Personal.—Mr. A. Howard Desforges (Hull representative of Messrs. Siemens Bros. & Co., Ltd., London) was married recently to Sophia (Jacq) Cornish at Holy Trinity Church, Woodford, Essex. The staff of the cable department of the above firm at Woolwich works presented an immense handsome gong.

Mr. Fred. C. Gibbons, M.Inst.E.E., who for the last 11 years has been a joint managing director of Messrs. Browett, Lindley & Co., Ltd., Patricroft, Manchester, has resigned his position with that company, and has taken up the English representation of Messrs. James Howden & Co., Scotland Street, Glasgow, for the sale of their high-speed engines and steam turbines. Messrs. Howden's London office is Billiter Buildings, 22, Billiter Street, and their Manchester office 39 to 40, Arcade Chambers, Deansgate.

Mr. E. A. Brandon, commercial manager of the Lahmeyer Electrical Co., Ltd., has rejoined the staff of Messrs. Johnson & Phillips, with whom he was previously associated for about 12 years.

British v. Foreign Tenders at St. Pancras.—Some important matters were dealt with at the meeting on Wednesday of St. Pancras Borough Council. The following tenders were received for cables required in connection with the extension of the public street lighting and distributing mains:—The Electrical Co., £5,982 6s. 2d.; W. F. Dennis & Co., £6,081 10s. 6d.; Johnson & Phillips, £6,465 10s. 2d.; Siemens Bros. & Co., £6,617 3s. 6d.; Callender's Cable and Construction Co., £6,661 9s. 8d.; Western Electric Co., £6,683 0s. 5d.; British Insulated and Helsby Cables, £6,690 12s. 8d.; W. T. Henley's Telegraph Works Co., £6,914 7s. 8d.; Anchor Cable Co., £6,923 3s. 8d.; W. T. Glover & Co., £7,173 10s. 10d.; St. Helens Cable Co., £7,486 11s. 11d.; Union Cable Co., £8,214 15s. 11d.

The chief electrical engineer, Mr. Sydney W. Baynes, having been requested by the Lighting Committee to report upon the British and foreign firms tendering, submitted the following statement:—"The firms offering cable of foreign manufacture are the Electrical Co. and W. F. Dennis & Co. The remaining tenders, as far as my knowledge goes, are for the supply of cables of English manufacture. Out of the English firms there are only two which comply with the requirements of the specification, viz., the Western Electric Co. and the Anchor Cable Co. The remaining English firms formed a strong association with the determination only to supply cables on their own terms as to payment, arbitration, and other details. Having regard to the fact that the results of our commercial trading are constantly under close observation, and that our figures are criticised with those of companies and other trading concerns, I consider it is desirable that we should make the best possible bargain for the cheapest materials, bearing in mind at the same time that these must be of the best possible quality. Bearing these points in mind, I recommend that the lowest tender be accepted, and although the cable will be of foreign manufacture, the firm have such a large experience that I have no hesitation in saying that their cable will comply in every respect with the requirements of my specification. Should the Council, however, decide in favour of English manufacture, the Western Electric Co.'s tender is the next on the list which would comply with our requirements, but I note that their tender is some £700 higher than that of the Electrical Co.'s; and in accepting this higher tender, the St. Pancras electric light undertaking will certainly be at a disadvantage with competing companies to this extent."

The Lighting Committee recommended the acceptance of the Electrical Co.'s tender. To this an amendment was moved that the tender of the Western Electric Co. be accepted.

A discussion upon the merits of Free Trade and Protection, lasting over two hours, resulted. In the course of this the town clerk read a letter from the Electrical Co. giving details of the wages paid and the hours worked by their employés. The communication went on to state that in every respect was the condition of the firm's workmen as good, while in several ways it was better than prevailed in this country. They were able to quote lower than English cable manufacturers, not because their workmen were paid less, but because their plant was better. The amendment was carried by 35 votes to 9.

On the amendment that the tender of the Western Electric Co. be accepted being put as a substantive motion, Mr. Kipplewhite moved that fresh tenders be called upon new specifications. He contended that the requirements laid down were obsolete and unfair, and had shut out a number of firms. Several members in opposing the proposal, condemned the "cable ring," which they argued sought unwarranted concessions. Only five members voted for the amendment. The tender of the Western Electric Co. was then accepted.

The following tenders were received for the supply of arc lamp carbons for the public street lamps:—De Grelle, Houdret & Co., £577 12s. 6d.; Crompton & Co., £592 15s. 3d.; Sloan Electrical Co., £592 15s. 3d.; Fabius Henrion, £599 14s. 2d.; International Electrical Engineering Co., £609 7s. 7d.; Birmingham Carbon Co., £616 5s. 1d.; G. Braulik, £616 19s. 8d; General Electric Co., £617 3s. 10d.; Veritys, Ltd., £628 18s. 8d.; International Electric Co., £639 8s. 8d.; Oscar Scholzig, £643 0s. 9d.; Fabius Henrion (alternative), £661 7s. 5d.; Bakewell & Co., £686 13s. 1d.; Johnson and Phillips, £690 6s.; Siemens Bros. & Co., £695; Improved Electric Lamp Co., £712 8s. 1d.; Krupka & Jacoby, £750 13s. 6d.; Witting, Eborall & Co., £793 13s.; Compagnie Francis, £858 15s. 2d.

The electrical engineer having been instructed to report upon the British and foreign tenders, submitted the following:—"Out of the 19 tenders, the Birmingham Carbon Co. and the General Electric Co. claim the carbons they offer will be of English manufacture. I have tested the samples of carbon submitted of English manufacture in comparison with those of the lowest tenderer, and find that the light is not so clear and white, neither is it of such an intensity. Further, by the requirements of the specification, the makers in each case are to state the consumption per hour that they are prepared to guarantee shall not be exceeded under standard burning conditions of the lamps; in each case the English make of carbon is stated to burn 1·35 centimetres per hour, while the carbons of the lowest tenderer burn 1·2 centimetres per hour. With regard to the question of carbons of English and foreign manufacture, it is worthy of note that during the past 20 years various firms in England have attempted to manufacture arc lamp carbons, and, up to the present, none of them have succeeded in putting a good reliable carbon on the market; many of them have abandoned their own manufacture, actually importing carbons because they have found the foreign carbon does their lamp better credit than those of their own make. The Birmingham Carbon Co. is the only firm to my knowledge at present pursuing the manufacture of carbons in this country, and I have good reason to believe that those offered by the General Electric Co. would come from the same works.

Successful arc lamp carbons are composed largely of pure carbon probably obtained from the deposit collected from the carbonisation of crude oils, whilst attempts are made by English manufacturers to make the carbons from the carbon of the gas retort, and consequently the quality is never to be compared with those of foreign production. In recommending Messrs. De Grelle, Houdret & Co.'s tender, I feel confident that to accept same would ensure efficient and reliable lighting in our streets." The Lighting Committee recommended the acceptance of Messrs. De Grelle, Houdret & Co.'s tender, and this was agreed to.

Eighteen tenders were received for wiring and fitting the artisans' dwellings in Great College Street with electric light. The tender of Messrs. R. H. and J. Pearson, High Street, Notting Hill, at £265, was accepted.

Auction Sale.—Messrs. Wheatley Kirk, Price & Co. are to offer for sale shortly the central station and plant of the Newcastle-on-Tyne Electric Supply Co., at Pandon Dene.

At the Brush Works.—A party of 60 members of the Nottingham Guild of Engineers, Mechanics and Electricians paid a visit to the works of the Brush Co. at Loughborough the other day.

Electricity in India.—The subject selected for the Dr. Theodore Cooke Memorial Prize, by the Bombay University Syndicate, for 1905, is "Electric Traction and the Application of Electricity to the Requirements of Cities in India." *Indian Engineering* says that competitors should be graduates in engineering of the University of Bombay of not more than seven years' standing.

New School of Electricity.—A school of electricity is to be established at the Harris Institute, Preston. The cost will be defrayed out of a legacy of £2,000 left for the purpose of advancing mechanical and electrical engineering by the late Mr. J. Billington Booth, J.P., engineer, of Preston. Of the bequest, £1,000 will be devoted to the electrical engineering department, which will be under the superintendence of Mr. G. E. Gittins.

Forthcoming Books.—Messrs. Archibald Constable and Co., Ltd., write:—"In the issue of September 4th of your valuable REVIEW, you devote three leading articles to three very important subjects:—'Dust Destructors,' 'Liquid Fuel,' and 'Smoke Abatement.' This prompts us to say, for the benefit of those of your readers who wish to study these questions, should you think it worth while to make the fact known, that we have in hand and shall *very shortly* publish, 'Liquid Fuel and its Combustion,' by W. H. Booth; a book on 'Dust Destructors,' by F. Goodrich; and a book on 'Smoke Prevention,' by W. H. Booth and J. B. C. Kershaw, all of which deal in a very exhaustive manner with the subjects of which they treat."

The American Workman: From an English Workman's Point of View.—In *Page's Magazine*, "W. H.," a workman who has spent many years in American shops, gives his views on the American workman. The blatant patriotism annoyed him, and considering the mixture of nationalities and the comparative scarcity of natives of several generations' descent, this feature struck him as somewhat remarkable. Whilst the men do not hustle, as we are led to believe, there is no loafing. They make themselves as comfortable as possible, sitting down to their work if they feel so inclined, and spreading an elaborate meal on the bench if hungry. The American workman is very particular about temperature, and the shops are kept at as uniform a temperature as possible, notwithstanding great variations outside. One reason for this appears to be that the American likes to work in his shirt, that is, without coat or waistcoat.

Any new idea, however trivial, is magnified into a great discovery, old and tried methods being discarded on the slightest pretext in favour of something new. The men are secretive and jealous of each other, scarcely asking questions for fear of showing ignorance. They rarely leave a shop without first picking a quarrel with the foreman or employer. The standard of living is higher than in England, although the American eats less in quantity. He dresses better, and lives in a better house. Of recent years, employment is more difficult to obtain than here, and wages, although higher than formerly, have a lower purchasing power. The men feel that they are not working so much for themselves or their country as for a few hundred millionaires at the top, and they do not look upon the men on top as their superiors.

The Impurities of Commercial Calcium Carbide.—In the course of a recent article upon the derivation of the usual impurities which are to be found in crude acetylene generated by the ordinary methods from calcium carbide, MM. Bullier and Maquenne state that carbide only contains calcium phosphide and sulphide because it is made in the electric furnace by what may be termed a "basic" process, that is to say, because the charge fed into the furnace contains an excess of lime. If the carbide could conveniently be prepared by an "acid" method, *i.e.*, from a charge containing an excess of carbon, the material would be free from calcium phosphide and sulphide; and the gas generated therefrom would accordingly be free from phosphorus. Bullier and Maquenne also assert that the actual impurity in carbide which causes crude acetylene to contain sulphur is scarcely known: it is not calcium monosulphide, for that is not decomposed by plain water, and experiments demonstrate that it is not aluminium sulphide. The sulphur probably exists in the carbide in the form of a compound of calcium, carbon and sulphur, which yields sulphuretted hydrogen when treated with water.

THE CENTRAL STATION ENGINEER.

MR. GEO. C. LAW, of Bow, has been appointed third engineer-in-charge of the Bermondsey electric light station. There were 47 candidates.

NEW COMPANIES REGISTERED.

Kolar Mines Power Station, Ltd. (78,537).—This company was registered on September 11th, with a capital of £90,000 in £1 shares, to erect, establish, instal and equip near the Kolar Gold Fields, India, or elsewhere a central electric power station or stations, and to carry on the business of an electric power supply company. The first subscribers are:—Sir C. Tennant, Bart, 40, Grosvenor Square, W., 11,339 shares; Capt. W. A. McTaggart, 151, Cannon Street, E.C., 7,769 shares; E. Taylor, 6, Queen Street Place, E.C., engineer, 6,659 shares; J. Taylor, M.I.C.E., 6, Queen Street Place, E.C., 3,158 shares; Lord Riddlesdale, 32, Green Street, W., 1,080 shares; R. Garland, 150, East Dulwich Grove, S.E., secretary, 1 share; W. L. Bayley, 6, Queen Street Place, E.C., secretary, 1 share; and F. H. Williams, 6, Queen Street Place, E.C., secretary, 1 share. No initial public issue. The number of directors is to be five, one being appointed by each of the following companies, viz.:—The Mysore Gold Mining Co., Ltd., the Champion Reef Gold Mining Co. of India, Ltd., the Nundydroog Co., Ltd., and the Balaghât Gold Mining Co., Ltd.

M.I.P. Electrical Syndicate, Ltd. (78,520).—This company was registered on September 9th, with a capital of £10,000 in £1 shares, to adopt an agreement with Sir A. J. C. Thornhill, Bart., for the acquisition of the benefit of certain existing inventions relating to the production of electricity, and to carry on the business of electricians, mechanical engineers, suppliers of electricity for light, heat, motive power or otherwise, manufacturers of and dealers in all apparatus used in connection with the generation, distribution, supply, accumulation and employment of electricity, &c. The first subscribers are:—J. W. Miller, 84, Portland Place, W., engineer; C. Blackman, Mansion House Chambers, E.C., engineer, 1 share; C. E. Warren, 75, Mansion House Chambers, E.C., 1 share; J. Crowby, St. Brelade, Hampton Wick, electrician, one share; R. Starke, 195, Upper Thames Street, E.C., merchant, 50 shares; A. E. Baines, 57, New Broad Street, E.C., merchant, 50 shares; and R. H. Wheeler, 220, Gresham House, E.C., merchant, 1 share. No initial public issue. The number of directors is not to be less than two nor more than five; the first are R. Starke and A. E. Baines; qualification, 50 shares.

Headley, Ltd. (78,535).—This company was registered on September 11th, with a capital of £10,000, in 7,000 ordinary shares of £1 each and 300 6 per cent. preference shares of £10 each, to adopt an agreement with F. H. Headley, and to carry on the business of electricians, electrical engineers, manufacturers, workers of, and dealers in, electricity, motive power, light and heat, founders, mechanical and general engineers, tool makers, &c. The first subscribers are:—F. H. Headley, Elm Cottage, St. Austell, 3,400 ordinary shares; A. Hicks, 3, Parade, Truro, accountant, 500 ordinary shares; E. Hicks, St. Austell, gentleman, 1 share; Mrs. A. B. Headley, Elm Cottage, St. Austell, 98 ordinary shares; Miss E. M. Hills, 79, Promenade, Southport, 1 ordinary share; M. Mead, Sunrise, Falmouth, mechanic, 100 ordinary shares; and J. Mead, Sunrise, Falmouth, mechanic, 1,900 ordinary shares. No initial public issue. The number of directors is not to be less than two nor more than five; the first are J. Mead, M. Mead, A. Hicks and F. H. Headley; qualification, 100 shares; remuneration for first year, £100 divisible; afterwards as fixed by the company. Registered office, Moresk Mills, Kenwyn, Truro.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

New Century Arc Light Co., Ltd. (67,849).—Issue on August 19th of a second debenture for £2,000, part of series created April 24th, 1903, to secure £5,000, charged as a floating security on the company's undertaking and property, present and future, including uncalled capital. Holders: S. Peebles, 2, Rutland House, Cheniston Gardens, Kensington. No trustees. Previously issued of same series, £3,000.

British Westinghouse Electric and Manufacturing Co., Ltd. (62,919).—A deed dated August 31st, 1903 (supplemental to principal trust deed of February 18th, 1902), securing £450,000 debenture stock created by board resolution of August 10th, 1903, has been registered. Property charged (specifically), same property as that comprised in principal trust deed, securing £787,500 stock, viz., freehold hereditaments partly in parish of Stretford, and partly in parish of Berton-upon-Irwell, Lancs., forming part of Trafford Park Estate, subject to certain rent charges. As a floating security: the company's other assets, present and future, including uncalled capital. Trustees: The Merchants' Trust, Ltd., 63, Cornhill, E.C.

CITY NOTES.

Chloride Electrical Storage Co., Ltd.

THE directors' report for the year ending June 30th, 1903, shows a trading profit for the financial year of £20,756 12s. 10d. After deducting directors' and auditors' fees (to June, 1902), debenture interest, depreciation, provision for bad debts, and interim dividend on preference shares, the available balance for the year is £6,030 4s. 4d., to which must be added £5,802 4s. 8d. brought forward from last year, making a disposable balance of £11,832 9s. The directors propose the payment of a dividend of 6 per cent. on the preference shares for the financial year, less interim dividend already paid, and a dividend of 8 per cent. on the ordinary shares, free of income-tax, together amounting to £4,520, and to carry forward the balance, £7,312 9s. During the year under review the Electric Storage Battery Company of Philadelphia, U.S.A., with which the company has always maintained close relations, acquired, by purchase of shares, a very large interest in the company. The directors, accordingly, elected Mr. Herbert Lloyd (President of the Electric Storage Battery Company), Mr. John R. Williams, Mr.

Robert E. Lloyd, and Mr. J. De Berniere Smith as directors to fill the vacant places on the board, in order that this interest might be adequately represented. Under the circumstances it is advisable that its reconstitution be reviewed and determined by the shareholders. The auditors, Messrs. Parkinson, Mather & Company, chartered accountants, retire in the usual course, and again offer themselves for re-election.

Sir Hiram Maxim Electrical Engineering Co.

Mr. J. de Meray presided at the annual meeting, held at Gillingham Street, S.W., on Monday, and, in moving the adoption of the report for the year ended December 31st, 1902, he said that during the year they had had many hard struggles and difficulties. A company competing against so many powerful and old-established firms could not expect to obtain a footing without a struggle. After protracted negotiations, the days of litigation with the Lamp Co. were over, and all differences were at an end, and they would now have support and friendly co-operation from quarters where bitter feelings had existed. In regard to the volume of the business done annually:—In 1900 they had only £14,636 to report; in 1901 the amount of business done amounted to £35,097. From the date of the last balance-sheet up to that day the contracting department had taken over £105,000 worth of contracts. In this current year they certainly should carry through over £100,000 worth of business, or seven times the turnover three years ago. Moreover, the field of operation is practically unlimited. They began some three years ago by taking from contractors small orders in connection with their contracts. Then they followed by making a speciality of all steam accessories for electrical power stations, taking big contracts in that special line of business, and made arrangements which enabled them to contract for the whole of the erection and complete equipment of electrical power stations. Lately they had extended the scope of the civil engineering and contracting department. They were also on the point of starting a boiler department. Their new boiler appeared, from the experiments already made, to meet the requirements of steam users in general. The company had taken a patent for the invention. The boiler had the advantage of the large capacity of the Lancashire and the rapid steaming qualities of tubular boilers combined. In January, 1902, they had to cancel the concession granted to Hiram Maxim Lamp Co. This concession provided for the sale of 1,000,000, or even, perhaps, 2,000,000 lamps a year. To cope with these orders, large sums of money had to be expended in the factory to thoroughly equip it and put it in a position to supply this large number of lamps. The lamp company failed to carry out their contract, and Mr. Hill, in January, 1902, found himself with very large works well equipped, ready to produce a large number of lamps; but, unfortunately, his only customer had vanished. It was, therefore, necessary to commence the business *de novo* to establish a new commercial department to deal with the sale of the lamps, and, notwithstanding those bad circumstances, the sale of the lamps increased every month, and had become a very important item. The lamp factory, which had occasioned a loss in the balance-sheet, which all deplored, had, however, laid the foundation of a steadily-increasing business. It was only a question of time for the lamp trade to grow, and become a paying department. Buying agents in many districts of the United Kingdom had been put under conditional agreement to take up a large number of lamps during the year. They had also turned their attention to a new arc lamp, and, after long experiments, had produced an arc lamp which in quality could compare with the very best arc lamp upon the market, and it could be supplied at a very much lower price than was being paid by consumers. The main difficulty which they had to contend against was, of course, the fact that the Continental manufacturers dumped down their surplus stocks on English markets at a less price than the goods could really be produced at in a legitimate way. However, there was every indication that there might be, before long, some fiscal changes, and if it were to happen that a duty were placed upon foreign imported lamps, it would mean an enormous impetus to the lamp trade. One of the greatest difficulties the directors had to contend with was, from the commencement, the shortness of the working capital. At the end of last year it was absolutely necessary that further capital should be put in the business; for that purpose they decided upon creating £20,000 of debentures. These debentures were offered to all the shareholders; but £15,000 was previously guaranteed by several of the members of the board and some of the leading shareholders. This guarantee was given without any underwriting commission or discount of any kind. The guarantee was given to help and assist the company, but in no way with any idea of profit to the guarantors, and as the business grew, and further money became necessary, it would be found whenever it was required. Taking everything into consideration, the prospects were exceedingly bright. He thoroughly sympathised with every disappointed shareholder that there was no dividend; but it must not be forgotten that the company had had to lay the foundation of, and create, a growing concern that was to become dividend-paying.

Sir Hiram Maxim seconded the motion, and he made a few hopeful remarks respecting an important invention which he had lately made—the nature of which he must not disclose until the patents were secured everywhere—in which there was a great deal of money; he had put thousands of pounds into it, and when it was proved, he believed it was going to be the means of putting the company on a paying basis. They must stick to their shares.

The resolution was carried unanimously.

The retiring directors were re-elected, and the resolution was passed increasing the capital of the company to £190,000 by the creation of 15,000 £1 ordinary shares to be exchanged for the debentures.

STOCKS AND SHARES.

Wednesday Evening.

If there should be any certainty of truth in the tradition that the darkest hours come before the dawn, then might the Stock Exchange congratulate itself upon a quickly-coming and a vast improvement in financial matters generally. A catalogue of factors adverse to the encouragement of investor or speculator might with ease be spread the length of this column; factors, too, of very present force, unlike the prophecies of hope that of course might also be made, but which would have to fix some vague future for the date of fulfilment. Were it not for the flatness of the markets in general, we should see better prices beginning to establish themselves in the electrical supply department, but so long as money is becoming dearer, Consols flatten, and the public confidence remains coy, a substantial improvement cannot be expected. Nevertheless, the strength of the market since the commencement of the current half-year is a good advertisement that is hardly likely to be overlooked when business once more returns to Capel Court.

Brompton and Kensington Supply Ordinary shares are ¼ better, and there the fluctuations in this list practically end. Chelsea shares have recovered their 2s. dividend. A few Smithfields came on offer the other day, and the seller only got 3¼ for them. Sir Hiram Maxim's dark reference of a new invention at the Maxim Electrical Co.'s meeting on Monday would appear to have something to do with aerial navigation, and shareholders in the concern will watch for its appearance with peculiar interest.

With regard to the Home Railways, the electrical stocks have suffered along with their steam compeers in the weakness that set in all along the line in the early part of this week. No doubt the little drop in Central London Deferred will be put down to the accidents that happened the other day, so happily unattended with any loss, even as the first mishap. The company may, indeed, regard itself as fortunate in passing through the ordeal unscathed, but this kind of thing does not tend to breed confidence amongst the nervous ones. City and South London has eased off a shade. Waterloo and City is unchanged, Great Northern and City Preferred "A" shares are 8, Great Northern, Piccadilly and Brompton 9⅜. District and Metropolitan at their respective prices of 33 and 83½, have now got to about the lowest levels touched this year in both cases. We have in front of us a private circular letter dated December 31st, 1902, by a well-known firm of stockbrokers, in which they advised their clients to buy Metropolitans for investment purposes, backing up their advice with cogent reasons, and a few comparisons with District figures. At that time the Metropolitan quotation stood at 91, but the advice looks as sound as it was when issued, and the fall is, of course, due to causes mostly unconnected with the intrinsic merit of stock. Incidentally it may be mentioned that the market in the Stock Exchange is greatly amused by the brick-making episode at Neasden.

British Electric Traction varieties are unchanged, and so are London United Tramways. A certain amount of business is passing in some of the Belgrano issues; the Ordinary change hands about 2½, and the 5 per cent. second Debenture found a buyer the other day at 100⅜. Brisbane Electric 4½ per cent. first mortgage Debenture has been done at 101¼, and Metropolitan Electric Tramways Preferred are being negotiated round about £1 a share.

In British Westinghouse Preference there has been a fair sprinkling of orders this week; the price clings closely to 5⅜ for the old and new alike. Westinghouse 4 per cent. Debenture is 101, and British Thomson-Houston 4½ per cent. Debenture stands at 105. Edison & Swan Debentures are both harder, a natural sequel to the slight demand for the shares to which we were directing attention last week. British Aluminium Debenture has hardened a trifle, though not quotably, and the nominal fall of ¼ in British Insulated is accounted for by the dividend deduction. Babcock & Wilcox shares are 3, Willans & Robinson 6, the Preference values in the respective cases being 1½ and 6½. Willans Debenture was bought for investment the other day at 101.

The recent storms and gales have made no more difference to the telegraph market than the Economic Notes on Insular Free Trade. Indo-European shares are a point up, but that is the solitary change worth mentioning. One or two of the National Telephone descriptions have improved to a small extent, but there is very little business doing in any of them.

Elmore's Trust, Limited.—An extraordinary general meeting was held at Winchester House on Monday, to consider a resolution to wind up the company voluntarily. Mr. Alleyne Reynolds presided. After a lengthy discussion it was decided to adjourn the meeting for a fortnight. A committee was appointed to confer and act with the board.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1900.	1901.	1902.	Closing Quotations Sept. 9th.	Closing Quotations Sept. 16th.	Business done week ended Sept. 16th, 1903. Highest	Lowest
67,100	African Direct Telegraph, 4 % Debs.	100	..	..	..	98 —102	98 —102	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	..	..	..	2⅛— 3⅛	2⅛— 3⅛	..	..
119,700£	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	..	..	..	70 — 80	70 — 80	..	..
788,840	Anglo-American Telegraph	Stock	3½%	6⅛.	6 0/6	47 — 50	47 — 50	..	..
3,105,580	Do. do. do. 6 % Pref.	Stock	6 %	6 %	6 %	90 — 92	91 — 93	91⅝	90⅝
3,105,580	Do. do. do. Deferred	Stock	6s. %	2s.	1/-	8 — 8½	8 — 8½	8	..
44,000	Chili Telephone, Nos. 1 to 44,000	5	5 %	5 %	6 %	4⅜— 5¼	4⅜— 5¼	..	..
13,333,300$	Commercial Cable	$100	8 %	8 %	8 %	150 —160	150 —160	..	..
1,841,209	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	..	..	..	93 — 96	93 — 96	..	..
16,000	Cuba Telegraph	10	4½%	4 %	6½%	7 — 8	7 — 8	..	..
6,000	Do. 10 % Pref.	10	..	..	..	16½— 17½	16½— 17½	..	..
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	2½— 3½	2½— 3½	..	..
6,000	Do. do. 10 % Cum. Pref.	5	..	..	..	7 — 8	7 — 8	..	..
90,000	Do. do. 4½ % Debs.	50	..	..	..	97 —101 %	97 —101 %	..	..
60,710£	Direct United States Cable	20	3¼%	3½%	3½%	10¼— 10¾	10¼— 10¾	10⅜	..
87,800	Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,200, Red.	100	..	..	..	99 —102	99 —102	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	124 —129	124 —129	126	125
1,955,565	Do. 3½ % Pref. Stock	100	..	..	..	90 — 93	90 — 93	92½	91
1,534,645	Do. 4 % Mort. Deb. Stock Red.	Stock	..	..	..	105 —108	105 —108	107	106⅞
300,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	12 — 12½	12 — 12½	12⅝	12⅜
320,000£	Do. 4 % Deb. Stock	Stock	..	..	..	104 —107	104 —107	..	..
300,000	Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 3,000, red. 1909	100	..	..	..	98 —101	98 —101	..	..
200,000£	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 8,000	25	..	..	..	100 —103 %	100 —103 %	102	..
180,227	Globe Telegraph and Trust	10	5½%	5½%	..	8⅜— 9⅜	8⅜— 9⅜	9	8⅞
180,042	Do. do. 6 % Pref.	10	..	..	..	12½— 13½	12½— 13½	13	12¾
150,000	Great Northern Telegraph, of Copenhagen	10	15 %	15 %	12½%	22 — 23	22 — 23	..	..
62,500£	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	..	..	..	99 —102	99 —102	..	..
17,000	Indo-European Telegraph	25	10 %	10 %	10%	36 — 39	37 — 40	39½	38
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	..	..	..	97 —101	97 —101	..	..
1,983,333	National Telephone, Pref. Stock	100	5 %	5 %	6 %	100 —102	100 —102	101⅜	100⅛
1,966,667	Do. do. Def. Stock	100	..	..	4½%	78 — 80	77 — 79	78⅜	77⅛
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13 — 14	13 — 14	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	13 — 14	13 — 14	..	..
2,250,000	Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000	5	5 %	5 %	5 %	5 — 5½	5 — 5½	5⅛	..
000,000£	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	95 — 97	94 — 96	..	..
600,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	101 —103	101 —103	102½	..
171,504	Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid	1	6 %	6 %	6 %	⅛— ⅛	⅛— ⅛	..	..
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	..	..	..	97 —100	97 —100	..	..
11,889	Reuter's	8	5 %	5 %	..	6½— 7½	6½— 7½	7½	6½
3,303	Submarine Cables Trust	Cert.	..	..	..	116 —121	116 —121	120	..
58,000	United River Plate Telephone	5	7 %	7 %	7 %	5½— 6	5½— 6	..	..
40,000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5	..	..	..	4⅝— 5¼	4⅝— 5¼	..	..
179,947£	Do. do. 5 % Debs.	Stock	..	..	..	104 —107	101 —107	..	..
15,609	West African Telegraph, Shares	10	..	..	2 %	5 — 6	5 — 6	..	..
150,000£	West Coast of America, 4% Debs., 1 to 1,500 guar. by Braz. Sub. Tel.	100	..	..	..	95 — 98	95 — 98	..	..
267,980	Western Telegraph, Ltd., Nos. 1 to 207,980	10	7 %	7 %	..	12 — 12½	12 — 12½	12⅜	..
75,000£	Do. do. 5 % Debs. 2nd series, 1906	100	..	..	..	100 —103	100 —103	..	..
400,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	98 —101	98 —101	..	..
88,321	West India and Panama Telegraph	10	½%	..	..	⅞— 1	⅞— 1	..	..
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	..	..	..	6 — 6½	6 — 6½	..	..
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	..	..	..	3½— 4½	3½— 4½	..	..
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	..	..	..	98 —101	98 —101	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

20,000	British Aluminium 7 % Cum. Pref.	10	..	..	..	3 — 4	3 — 4	..	3..
300,000£	Do. do. 5 % 1st Mort. Deb. Stock Red.	Stock	..	..	..	83 — 87	83 — 87	86	..
100,000	British Electric Traction	10	9 %	9 %	8 %	12½— 13	12½— 13	12⅝	12⅞
100,000	Do. do. 6 % Cum. Pref.	10	..	..	..	11½— 12	11⅝— 12	11⅝	11⅜
600,000£	Do. do. 5 % Perpetual Debenture Stock	Stock	..	..	..	122 —125	122 —125	124½	..
100,000	British Insulated and Helsby Cables	5	15 %	10 %	10 %	6¾— 7¼	6¾— 7 xd	..	..
100,000	Do. do. 6 % Cum. Pref.	5	..	..	..	5¾— 5¾	5¾— 5¾ xd	5⅝	..
50,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	..	..	..	102 —106	102 —106	..	..
50,000	¶Browett, Lindley & Co., Ord.	£1	8 %	Nil	..	⅞— 1⅛	⅞— 1⅛	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	6 %	6 %	..	14/6 to 15/6	14/6 to 15/6	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731	2	5 %	Nil	Nil	¾— 1¼	¾— 1¼	1	1⅛
150,000	Do. do. Non-cum. 6 % Pref.	2	6 %	3 %	6 %	1 — 1½	1 — 1½	..	..
125,000£	Do. do. 4½ % Perp. Deb. Stock	Stock	..	..	..	97 —100	97 —100	..	..
125,000£	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	..	..	..	85 — 90	85 — 90	..	..
85,000	Callender's Cable Construction shares	5	15 %	20 %	15 %	11¼— 12½	11¼— 12½ xd	..	..
40,000	Do. do. do. 5 % Cum. Pref.	5	..	..	..	5¼— 5¾	5½— 5¾	..	..
90,000£	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	..	..	..	106 —110	106 —110	..	..
1,860,014	Central London Railway, Ord. Stock	Stock	..	4 %	4 %	98 —101	97 —100	99	98
494,098	Do. do. 4 % Pref. Stock	Stock	..	4 %	4 %	100 —103	99 —102	..	..
494,998	Do. do. Def. do.	Stock	..	4 %	4 %	101 —104	99 —102	..	..
1,830,000	City and South London Railway	Stock	1½%	2 %	3½%	59 — 61	58 — 60	59⅜	59
85,000	Crompton & Co., Nos. 1 to 85,000	3	8 %	7½%	5 %	2 — 2½	2 — 2½	2⅝	..
100,000£	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red.	..	..	..	..	100 —104	100 —104	..	..
99,261	Edison & Swan United Elec. Light, "A" shares, £3 paid, 1 to 99,261	5	2½%	Nil	..	0 — ¼	0 — ¼	..	..
17,139	Do. do. "A" shares, 01—017,139	5	2½%	Nil	..	1½— 2⅜	1½— 2⅜	..	..
344,023£	Do. do. 4 % Deb. Stock Red.	100	..	..	..	71 — 75	72 — 77	72½	..
100,000£	Do. do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	..	..	..	75 — 80	77 — 82	..	..
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	6 %	1½— 1⅝	1½— 1⅝	..	..
31,390	Do. do. 7 % Cum. Pref., 1 to 31,390	2	..	..	..	2½— 3	2½— 3	..	..
82,500£	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	..	..	..	98 —101	98 —101	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	5 %	9½— 10	9½— 10	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	..	..	..	99 —102	97 —100	..	..
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	20 %	20 %	20 %	13½ - 14½ xd	13½— 14½	..	..
35,000	Do. do. 4½ % Pref.	5	4½%	..	..	5 — 5½ xd	5 — 5½	..	..
48,050	Do. do. 4½ Mort. Deb. Stock	Stock	..	..	..	107 —111 xd	107 —111	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10 %	10 %	18½— 19½	18½— 19½	19	..
800,000£	Do. do. do. 4 % 1st Mort. Deb.	100	..	..	..	100 —103	100 —103	..	..
37,500	†Liverpool Overhead Railway, Ord.	10	3½%	1½%	1½%	5 — 5½	5½— 5⅝	..	..
10,000	† Do. do. Pref. £10 paid	10	..	..	..	10½— 10⅝	10½— 11	..	..
37,350	Telegraph Construction and Maintenance	12	17½%	20 %	20 %	34 — 37	34 — 37	36	35½
150,000£	Do. do. 4 % Deb. Bds., Nos. 1 to 1,500 Red. 1909	100	..	..	..	100 —103	100 —103	..	..
540,000£	Waterloo & City Railway, Ord. Stock	100	3 %	3 %	3½%	95— 98	94 — 97	95½	..

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ From Manchester Share List.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

National Electric Free Wiring, ⅜—½.

Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 14½—14⅞.
Do. do. Pref. (£10 pd.), 11 —10½.

Bank rate of discount 4 per cent. (September 3rd, 1903).

SHARE LIST OF ELECTRICAL COMPANIES (*continued*).—ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME,	Stock or Share.	Dividends for the last three years. 1900.	1901.	1902.	Closing Quotations Sept. 9th.	Closing Quotations Sept. 16th.	Business done week ended Sept. 16th, 1903. Highest.	Lowest
		‡							
100,000	Blackheath and Greenwich Dist. Electric Light, Ord...	1	..	..	..	5/8 — 7/8	5/8 — 7/8	..	..
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs. ..	100	..	..	..	118 —121	118 —121	..	..
20,000	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000 ..	5	6 %	8 %	8 %	10¾— 11	10⅞— 11¼	11	..
20,000	Do. do. 7 % Cum. Pref. ..	5	..	..	..	10¼— 10⅜	10¼— 10⅜	..	..
50,000	Charing Cross and Strand Electricity Supply	5	9 %	10 %	10 %	9 — 9⅛	9 — 9⅛	9⅛	9¼
70,000	Do. do. do. 4½% Cum. Pref. ..	5	..	..	..	5⅝— 6	5⅝— 6	5⅝	5⅝
40,000	Do. do. "City Undertaking" 4½% Cum. Pref. ..	5	..	..	..	4⅜— 5	4⅜— 5	4⅜	4⅜
250,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	104 —106	104 —106	106	..
44,436	*Chelsea Electricity Supply, Ord.	5	5½%	4 %	4½%	5⅝— 6¼	5⅝— 6¼xd	..	..
150,000£	Do. do. % Deb. Stock Red.	Stock	..	..	..	108 —111	108 —111	..	..
70,595	City of London Electric Lighting, Ord. 40,001—110,595 ..	10	0 %	5 %	5 %	10½— 11	10½— 11	10⅝	10¾
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	..	..	13 — 14	13 — 14	..	..
400,000£	Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid	..	..	..	..	122 —127	122 —127	..	..
800,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100	..	..	..	102 —105	102 —105	..	..
40,000	County of London & Brush Prov. Electric Lighting, Ord. 1—40,000..	10	4 %	4 %	4 %	7⅞— 8⅛	7⅞— 8⅛	8⅛	..
20,000	Do. do. do. 6 % Pref., 40,001—60,000..	10	..	..	..	11½— 12⅛	11½— 12⅛	..	..
400,000£	Do. do. 4½% Deb. Stock, Prov. Certs. (all paid) Red ..	..	..	..	..	109 —112	109 —112	..	..
50,000	Edmundson's Electric Corporation, Ord. Shares	5	7 %	7 %	7 %	6¾— 7	6¾— 7	6⅞	..
30,000	Do. do. 6 % Cum. Pref.	..	..	..	..	6½— 6⅝	6½— 6⅝	6½	..
140,000	Do. do. 4½% 1st Mort. Deb. Stock ..	100	..	..	..	107 —110	107 —110	..	..
21,000	Kensington and Knightsbridge Electric, Ord.	5	12 %	10 %	10 %	10½— 11½	10½— 11½	..	..
90,000	Do. do. do. 4 % Debenture Stock ..	Stock	..	..	..	103 —106	103 —106	..	..
110,000	London Electric Supply Corporation, Limited, Ord.	3	..	..	..	2 — 2⅛	2 — 2⅛	..	..
49,840	Do. do. do. 6 % Pref.	5	..	..	..	5⅝— 6	5⅝— 6	5¹¹/₁₆	..
250,000£	Do. do. do. 4 % 1st Mort. Deb. Stock Red	Stock	..	..	..	100 —102	100 —102	..	..
100,000	Metropolitan Electric Supply, 1 to 100,000	10	6 %	6¼%	7½%	17½— 18¼	17½— 18⅜	18⅞	17⅞
220,000£	Do. do. 4½% 1st Mort. Deb. Stock	..	..	..	..	108 —112	109 —113	110⅛	110⅝
250,000£	Do. do. 3½% Mort. Deb. Stock Red	Stock	..	..	..	97 —100	97 —100	..	..
10,852	Notting Hill Electric Lighting	10	7 %	6 %	6 %	13 — 14	13 — 14	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	15½— 16½	15⅝— 16⅝	15⅝	..
20,000	Do. do. do. 7 % Pref. 20,081 to 40,080	5	..	..	..	8 — 9	8 — 9	8⅝	..
150,000£	Do. do. do. 3½% Deb. Stock Red ..	100	..	..	..	98 —101	98 —101	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	..	..	2½%	3⅜— 3⅞	3⅜— 3⅞	3¾	..
65,000	South London Electricity Supply, Ord.	5	..	..	1½%	3⅞— 4¼	3⅞— 4¼	..	..
80,000	Urban Electric Supply, Ord.	5	..	..	..	5 — 5⅛	5 — 5⅛	..	..
80,000	Do. do. 5 % Cum. Pref.	5	..	..	..	5 — 5⅛	5 — 5⅛	..	..
110,000	Westminster Electric Supply, Ord.	5	10½%	10½%	12 %	13 — 14	13 — 14	13⅜	13⅜
28,141	Do. do. 5 % Cum. Pref.	5	..	..	..	6 — 6½	6 — 6½	..	..

*Subject to Founders Shares. ‡Unless otherwise stated all shares are fully paid.

MARKET QUOTATIONS, Wednesday, September 16th.

	CHEMICALS, &c.		Latest Price.	Week's Inc. or Dec.
a	Acid, Hydrochloric	per cwt.	5/-	..
a	„ Nitric	per cwt.	22/-	..
a	„ Oxalic	per cwt.	32/-	..
a	„ Sulphuric	per cwt.	5/6	..
a	Ammoniac, Sal	per cwt.	42/-	..
a	Ammonia, Muriate (crystal) ..	per ton	£33 10	..
a	„ „	per ton	£30	..
a	Bleaching powder	per ton	£4 10	..
a	Bisulphide of Carbon	per ton	£15	..
a	Borax	per ton	£13	..
a	Benzole (90 %)	per gal.	7/-	..
a	„ (50/90 %)	per gal.	5/6	..
a	Copper Sulphate	per ton	£20	..
a	Lead, Nitrate	per ton	£24	..
a	„ White Sugar	per ton	£31	..
a	„ Peroxide	per ton	£27 10	..
a	Methylated Spirit	per gal.	2/6	..
a	Naphtha, Solvent (90% at 160° C).	per gal.	5/6	..
a	Potash, Bichromate, in casks ..	per lb.	3d.	..
a	„ Caustic (75/80%)	per ton	£24	..
a	„ Bisulphate	per ton	£35	..
a	Shellac	per cwt.	167/-	10s. inc.
a	Sulphate of Magnesia	per ton	£4 10	..
a	Sulphur, Sublimed Flowers ..	per ton	£6 10	..
a	„ Recovered	per ton	£5 10	..
a	„ Lump	per ton	£5	..
a	Soda, Caustic (white 70 %) ..	per ton	£10 15	..
a	„ Crystals	per ton	£3	..
a	„ Bichromate, casks	per lb.	2½d.	..
	METALS, &c.			
b	Aluminium Ingots, in ton lots ..	per ton	£130	..
b	„ Wire, in ton lots ..	per ton	£168	..
b	„ Sheet, in ton lots ..	per ton	£166	..
p	Babbitt's metal ingots	per ton	£43 to £145	..
e	Brass (rolled metal 2' to 12') basis	per lb.	7d.	..
e	„ Tube (brazed)	per lb.	8¾d	..
e	„ „ (solid drawn)	per lb.	7¾d.	..
e	„ Wire, basis	per lb.	7¼d.	..
c	Copper Tubes (brazed)	per lb.	9½d.	..
c	„ „ (solid drawn) ..	per lb.	9¾d.	..
g	Copper Bars (best selected ..	per ton	£75	..

	METALS, &c. (*continued*).		Latest Price.	Week's Inc. or Dec.
g	Copper Sheet	per ton	£75	..
g	„ Rod	per ton	£75	..
e	„ (Electrolytic) Bars ..	per ton	£67	£1 inc.
e	„ „ Sheets ..	per ton	£77	£1 inc.
e	„ „ Rod	per ton	£69	£1 inc.
e	„ „ H.C. Wire	per lb.	8¼d.	¼d. inc.
f	Ebonite Rod	per lb.	3/8	..
f	„ Sheet	per lb.	8/-	..
n	German Silver Wire	per lb.	1/6	..
h	Gutta-percha fine	per lb.	8/-	..
h	India-rubber, Para fine	per lb.	4/5½ to 4/7	2½d. inc.
i	Iron, Charcoal Sheets	per ton	£18	..
i	„ Pig (Cleveland warrants)	per ton	45/11	1/- dec.
i	„ Forgings, according to size	per ton	From £11	..
i	„ Scrap, heavy	per ton	47/6 to 50/-	..
i	„ Wire, galvanised No. 8 ..	per ton	£9 15	..
g	Lead, English Ingot	per ton	£11 10 to £11 12 6	..
g	„ „ Sheet	per ton	£13	..
m	Manganin Wire No. 28	per lb.	8/-	..
g	Mercury	per bot.	£8 7 6	..
d	Mica (in original cases) small ..	per lb.	4d. to 1/6	..
d	„ „ „ medium	per lb.	2/6 to 3/9	..
d	„ „ „ large ..	per lb.	4/- to 7/9	..
p	Phosphor Bronze, plain castings	per lb.	1/- to 1/2½	..
p	„ rolled bars & rods	per lb.	1/1 to 1/4	..
p	„ „ strip & sheet	per lb.	From 1/2	..
o	Platinum	per oz.	£4	..
p	Silicium Bronze Wire	per lb.	10d. to 1/-	..
i	Steel, Magnet, acc'd'g to desc'p'n	per ton	£58	..
i	„ „ in bars		£15 to £40	..
g	Tin, Block	per ton	£122 to £123	£2 to £3 dec.
g	„ Foil	per lb.	1/6	..
n	„ Wire, Nos. 1 to 16	per lb.	1/7	..
p	White Anti-friction Metals—			
	"White Ant" brand ..	per ton	£42 to £65	..
j	Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	8d.	..
j	„ 6 lea. Flax	per lb.	5⅜d.	..
j	„ 3 ply 10 lbs. Russian ..	per lb.	4¹³/₁₆d.	..
j	„ 10 lbs. Russian, single ..	per lb.	4⅜d.	..
j	„ 180 lbs. Jute rove ..	per ton	£11	..
k	Zinc, Sh't (Vieille Montagne bnd.)	per ton	£24 5	..

Quotations supplied by Messrs.:—*a* G. Boor & Co.; *b* The British Aluminium Co., Ltd.; *c* Thos. Bolton & Sons., Ltd.; *d* F. Wiggins & Sons.; *e* Frederick Smith & Co.; *f* India-Rubber, G.P. and Teleg. Works Co., Ltd.; *g* James & Shakspeare; *h* Edward Till & Co.; *i* Bolling & Lowe; *j* Walter H. Hindley and Co., Ltd.; *k* Morris Ashby, Ltd.; *m* W. T. Glover & Co., Ltd.; *n* P. Ormiston & Sons; *o* Johnson, Matthey & Co., Ltd.; *p* The Phosphor Bronze Co., Ltd.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

	Locality.	Week ending	Receipts for the week. £	£*	Total to date. £	£*	Miles open. *	
	Aberdeen	Sep. 12	1,255	+169	20,011	+ 2,551	10	—
	Birmingham	„ 12	5,138	+ 50	187,021	+ 8,294	—	—
	Bournemouth	„ 9	1,391	—	—	—	10½	—
	Blackburn	June 26	909	—286	11,668	+ 674	12½	+1½
	Blackpool	Sep. 10	1,688	—495	29,059	— 118	8½	—
	Blackpool and Fleetwood	„ 12	1,141	—354	15,227	— 48	7½	—
	Bolton	„ 13	1,827	+261	45,602	+ 6,077	25	—
	Bradford	Aug. 23	4,267	+579	81,276	+13,000	41	+4
	Brighton	Sep. 13	1,010	— 29	37,196	—	6½	—
	Bristol	„ 11	5,140	— 40	—	—	28	—
	Burnley	„ 12	956	+192	—	—	7½	—
British Elec. Trac. Co.	Barnsley District	„ 4	171	—	6,428	—	4½	—
	Devonport	„ 4	491	— 23	15,829	+ 402	5	—
	Dudley—Stourbridge..	„ 4	942	+ 75	29,638	+ 2,948	18½	—
	Gateshead	„ 4	889	+ 17	30,560	+ 4,541	10½	+ ½
	Gravesend—Northfleet	„ 4	313	+109	8,453	+ 577	3½	—
	Greenock—Pt. Glasgow	„ 4	644	+ 8	19,364	+ 1,500	7½	—
	Hartlepool	„ 4	805	— 25	9,598	+ 388	6½	+2
	Kidderminster	„ 4	138	— 6	4,679	+ 198	4½	—
	Merthyr	„ 4	216	+ 3	7,004	— 244	3	—
	Middleton	„ 4	404	+ 40	11,651	+ 1,401	8½	—
	Oldham—Ashton ..	„ 4	612	— 39	20,357	+ 1,547	8	—
	Peterborough	„ 4	176	—	5,197	—	—	—
	Poole	„ 4	428	+ 77	10,599	+ 1,683	3½	—
	Potteries	„ 4	1,670	+ 80	54,792	+ 2,949	28½	—
	Rothesay	„ 4	243	— 3	5,840	+ 1,637	2½	—
	Sheerness	„ 2	106	—	2,075	—	2½	—
	Southport	„ 4	417	+ 22	11,262	+ 2,018	5½	—

* Compared with the corresponding period of 1902.

	Locality.	Week ending	Receipts for the week. £	£*	Total to date. £	£*	Miles open. *	
B.E.T. Co.	South Staffordshire ..	Sep. 4	1,066	+362	31,395	+ 4,045	21½	—½
	Swansea	„ 4	617	+ 85	18,505	+ 1,601	5½	—
	Taunton	„ 4	74	— 5	2,197	— 197	1½	+1½
	Tynemouth	„ 4	382	— 64	11,579	+ 950	3½	—
	Weston-super-Mare..	„ 2	273	— 36	4,580	— 417	2½	+2½
	Wolverhampton Dist.	„ 4	392	+ 82	13,915	+ 6,858	10½	+8
	Wrexham	„ 4	144	—	3,243	—	—	—
	Yorks. Woollen Dist. ..	„ 4	522	—	9,787	—	6	—
	Cardiff	„ 12	2,096	+390	48,258	+14,644	14	—
	Chatham & District Co.	„ 10	657	+ 86	19,299	+12,601	8·53	—
	Dover	„ 12	371	— 16	8,330	+ 50	3	—
	Dublin	„ 11	5,123	+141	61,705	+ 6,149	46½	+ ½
	East Ham	„ 12	710	+128	16,781	+ 5,205	5	+ ¼
	Glasgow	„ 12	14,130	+1429	201,486	+21,967	66	+ 9
	Hull	„ 12	1,914	+184	43,989	+ 2,060	11	+ 1
	Ilkeston	„ 9	183	—	—	—	4	—
	Isle of Thanet	„ 12	1,292	—308	27,007	— 1,240	10½	—
	Leeds	„ 12	5,658	+430	136,707	+ 7,806	41	—
	Liverpool	„ 5	10,427	—246	360,511	+11,627	100	+1½
	Manchester	„ 12	12,489	+6797	284,396	+178,469	72	—
	Newcastle	„ 12	3,508	+599	—	—	17	—
	Portsmouth	„ 12	2,113	+ 51	—	—	29	—
	Salford	Aug. 24	3,856	+1135	79,469	+24,703	30	—
	Southampton	Sep. 10	1,205	+ 6	—	—	9	—
	Sunderland	„ 6	1,374	+ 47	59,549	+ 810	20	+3
	Central London Railway	„ 12	5,537	—600	66,465	— 2,548	6	—
	City and S. London Ry.	„ 13	2,682	—397	26,906	— 3,458	6½	—
	Dublin and Lucan Elwy.	„ 13	129	+ 5	1,629	+ 85	6½	—
	Liverpool Overhead Ry.	„ 13	1,672	+150	18,906	+ 1,088	6	—

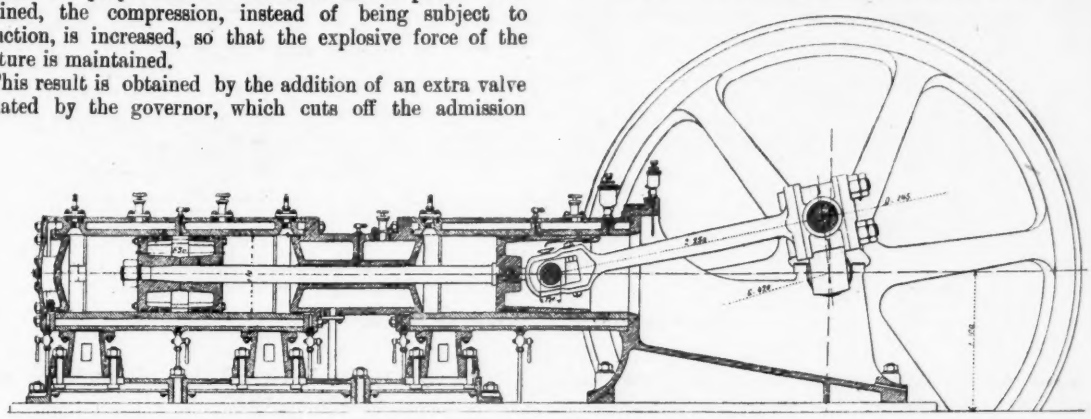
THE GAS ENGINE AND ITS FUTURE.

(*Continued from page* 409.)

Letombe Gas Engine.

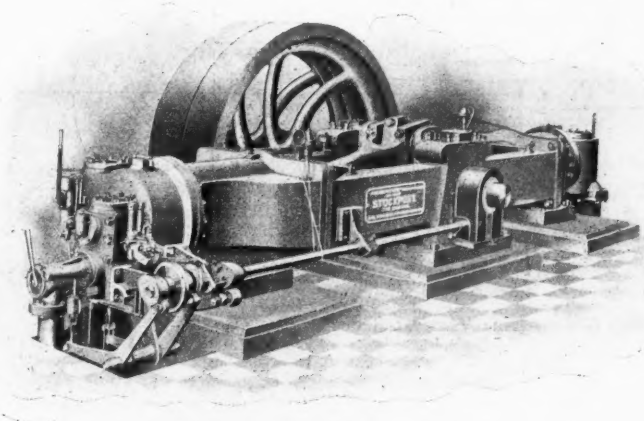
Another type of gas engine lately introduced is that of M. Letombe, in which, while the admission of gas is reduced in proportion to the reduction of power to be attained, the compression, instead of being subject to reduction, is increased, so that the explosive force of the mixture is maintained.

This result is obtained by the addition of an extra valve actuated by the governor, which cuts off the admission earlier as the mixture is richer. The expansion in this engine is prolonged, and therefore the reduction of temperature of the gas and the cylinder is increased.



Letombe Gas Engine: Vertical Section.

A prominent feature of this engine consists in the addition of a trunk piston in place of a cross-head guide in front of a double-acting cylinder. This arrangement gives an increase of power of 50 per cent. without a corresponding increase in weight. Though the Otto four-stroke cycle is adhered to, three strokes out of four are power strokes.



Stockport Gas Engine.—Fig. 1: 300-h.p. Engine.

For an engine of this type capable of developing 1,000 h.p. the pistons would only be 39⅜ in. diameter, with a single crank, while the governor is so arranged that the engine can be worked single, double, or triple-acting. Engines of the above type up to 1,500 and 2,000 h.p. are stated to be in course of erection.

The illustration at the top of this page shows the vertical section of a 400-h.p. mono-triplex Letombe gas engine.

Stockport Gas Engine.

The "Stockport" Gas Engine, manufactured by Messrs. J. E. H. Andrews & Co., Ltd., is built in the larger sizes of from 50 to 300 h.p.; fig. 1 above shows a two-cylinder 300-h.p. engine. The cycle employed by this firm is the Otto four-cycle, with tube ignition, though when preferred, they fit the engines with electric ignition.

In regard to the employment of heavy fly-wheels for reducing the cyclic irregularity, the following test shows that the increase of the weight of the fly-wheel has very little effect in reducing the power development of the engine:—

An engine of 340 i.h.p., as illustrated, was tested with fly-wheels weighing 6 tons 15 cwt. and 13 tons, the friction loads being respectively 30·87 h.p. and 32·32 h.p.; the difference, therefore, in the friction load between one and two wheels was 1·45 h.p., equal to ·42 per cent. of the total i.h.p. of the engine. This firm prefers a piston speed of 750 ft. per min., with a maximum of 300 r.p.m.

Fig. 2 is a diagram taken from an 80 b.h.p. "Stockport" gas engine, showing the variation in speed and steadiness.

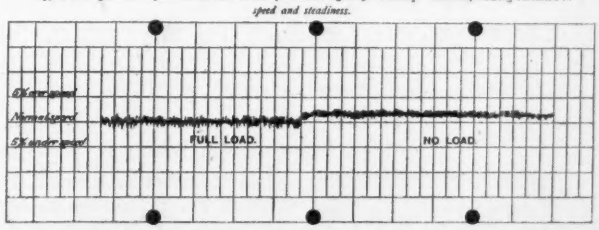
Reference has been made to the application of blast furnace gas to the driving of gas engines, and to the fact that to this quality of gas was due the great advance in cylinder diameter; the reason being that the gas from any one or more blast furnaces, while the ore, flux and fuel remain constant, varies only *very slightly* in its thermal quality, and has only a small percentage of hydrogen associated with the 25 to 30 per cent. of carbon monoxide gas.

The comparative absence of hydrogen is responsible for the fact that the ignition point is more under control, and the maximum force of explosion at the dead centre is capable of being retarded, thus obtaining an improved turning moment.

Blast-Furnace Gas Engine.

The pioneer of the application of blast furnace gas to internal combustion engines was Mr. B. H. Thwaite, and in our issues of December 15th and 22nd, 1899, April 27th, 1900, December 14th, 21st and 28th, 1900, we have referred to this question. The article on December 14th, 1900, gave particulars of an installation for the generation of electric current for both power and lighting purposes at an ironworks in Derbyshire. On the following page we give illustrations showing the latest gas engine to the designs of the Blast Furnace Power Syndicate (the owners of the Thwaite-Gardner patents) due to their extended experience with this quality of gas. It will be noticed that the engine is of the four-cycle Otto type. The cylinder is 36 in. in diameter, with a stroke of 48 in. It will

Copy of a Diagram taken from an 80 B.H.P. Stockport Gas Engine by "Moscrop" Recorder, showing variation in speed and steadiness.



Stockport Gas Engine.—Fig 2

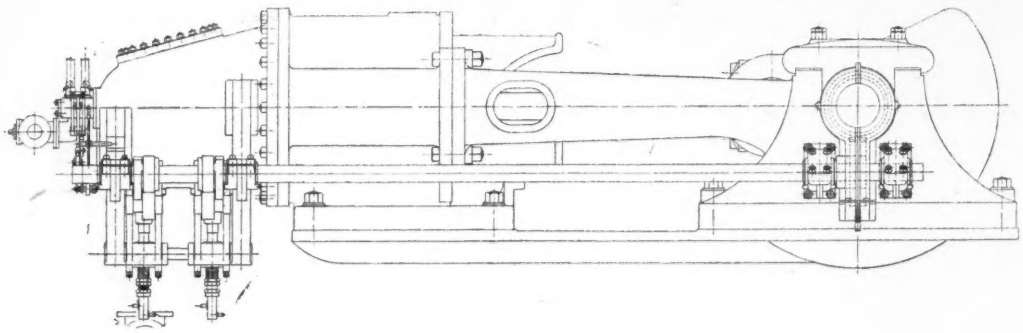
be seen that besides the usual water-jacket for the cylinder and combustion chamber, the piston and the inlet and exhaust valves are water-cooled. The system of governing adopted is a combination of the regulation of the charge and the "hit-or-miss."

As the power requirement falls, the governor diminishes the admission of gas and air, until a point is reached at which the reduced mixture might not ignite with certainty, when the gas supply is cut right off, and at the same instant the air supply is opened to its full extent. The valves are mechanically opened and closed by means of double arm levers, thus dispensing with the heavy springs usually adopted for closing the valves when single levers are actuated by cams.

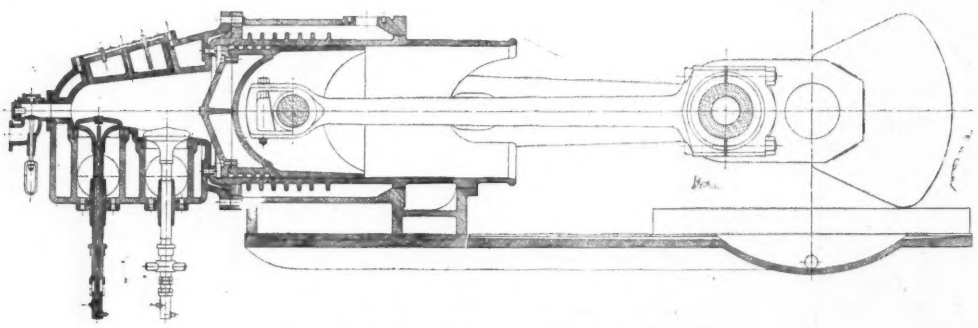
A valve is also arranged for admitting air under pressure, for scavenging purposes. A notable feature is that the inlet and exhaust valves have a constant and regular stroke, all regulation of compression, &c., being done by the scavenging valve.

Special tube ignition, in duplicate, permits of the engine being run continuously for long periods. With a piston speed of 800 ft. per minute, a single cylinder engine would be capable of developing 300 I.H.P.; four cylinders arranged double tandem would therefore give 1,200 I.H.P.

(*To be concluded.*)



Blast Furnace Gas Engine: Elevation.



Blast Furnace Gas Engine: Vertical Section.

PROTECTION: A REPLY TO MR. BYNG.

[COMMUNICATED.]

(*Concluded from page* 417.)

What is true of Ireland is true of most other countries, and the difference in the prosperity of the different parts of Ireland can be traced to the difference in the conditions of land tenure. After we have exhausted every argument for and against Free Trade or Protection, there is the feeling that the last word has not been said. That word is private ownership in land. To say that Free Trade is correct in theory, but wrong in practice, which is what the Protectionist arguments amount to, is no more logical than to impeach the law of gravitation because a suspended apple does not fall to the ground. Gravitation will not cause a boulder to roll down a hill side if the boulder be obstructed, but Newton's law holds good notwithstanding.

But this is a digression. I introduce the subject here because Mr. Byng has a word to say about landlords.

He quarrels with the unselfishness of landlords, who by "allowing free importation of agricultural produce have allowed rents to be reduced, and the capital value of land to fall by nearly £2,000,000,000."

This remark obviously suggests taxing imported agricultural produce, which is indeed unavoidable if we are to give a preference to our colonies. But what does Mr. Byng's book say on this point?

On p. 69 it says, "If we except the free importation of raw produce (and let me say at once that no sane Protectionist would ever place duties upon articles which Nature prevents our producing ourselves)," &c. . . . This sentence implies that agricultural produce should not be taxed, yet with characteristic inconsistency, the author tells us on p. 195, "We must protect our agriculture. It is the most pressing problem of the day."

But is Mr. Byng right in saying Free Trade has reduced rents? The available statistics seem to prove the contrary. Whilst the money rental of agricultural land has decreased, the rental of building land has steadily increased, and according to Prof. Marshall (Principles of Economics, book vii., p. 722) "the money rental of England's soil is probably twice as high, and the *real* rental three or four times as high as when the corn laws were repealed."

As a matter of fact, land itself has *no* value. Its value can only arise from the expenditure on it of human labour for which the worker is penalised.

It is, perhaps, hardly worth while to touch all the other points arising out of Mr. Byng's interesting letter, but as there are one or two little misconceptions I would like to clear up, I must trespass a little longer.

On the subject of wages, I did not for a moment doubt Mr. Byng's good intentions, nor suppose he wished to mislead his workmen. I am not so sure, however, that he does not mislead himself. He is again confusing value with money. That he would increase the money wages goes without saying; he would have to, in order to avoid a strike of his workmen. It does not at all follow, however, that the men would be better, or even as well off as before. On Mr. Byng's own showing, rents ought to rise as a result of

Protection; and a man's available wages are the balance after paying his rent. With this balance, would he be able to purchase as much as he does with the same amount at present? Mr. Byng makes a great deal of the fact (or fiction?) that wages are higher in Protected than in Free Trade countries, but he does not give any statistics either as to the money wages or the purchasing power in different countries. Money wages are higher in America than here, but so they were when England was a more strongly Protectionist country than America, so the argument does not apply in this case. Then what about Germany? Are wages higher there? No. In the show factory of Germany, viz., the Krupp Works, the skilled mechanics' wages in 1900 were below 5s. a day. But, as already pointed out, the actual money wages are not a safe guide, and it is more instructive to look into the actual conditions of living among the working classes. In *Das Wirtschaftsjahr*, 1902, there is to be found an impartial survey of German trade. In the factory inspectors' report we read that, owing to the depression in German industry, and the diminished earnings of the working class, the number of horses and dogs slaughtered for human consumption largely increased.

In consequence of the increased demand for horse-flesh, the Berlin horse slaughterers, unable to supply the requirements in the immediate neighbourhood of the capital, were compelled to send out agents to purchase horses in the provinces. Perhaps it is some satisfaction to Protectionist advocates to know that we export horses to the Continent for food, horses that can scarcely stand, and which require careful handling to prevent their dying on the journey. Poor wretched things! I have seen many of them on their way to the quayside, and, be it noted, that German exports to England were very great during the period referred to. This, then, is the country whose methods we are asked to imitate!

The British workman will hesitate a long time before changing his present diet for horse flesh and black bread.

And now, what about the "quantity" argument. "You grant that quantity pays," writes Mr. Byng. No, no, not so fast please. What I said was "by manufacturing standard parts in large quantities, the labour costs, and the standing charges on each part, may be very considerably reduced, and it is in this way, and only in this way, that 'quantity' pays."

This is not Mr. Byng's idea at all. He says distinctly that the cost of production does *not* depend on the cost of labour, the cost of material, and expenses, but on *quantity*; this factor overshadows the others. He gives as an example (pp. 10 and 11 "Protection") the manufacture of 50,000 foreign watches. He fixes the standing charges, including interest and depreciation on the labour-saving machinery, at £5,000 a year; and gives as the costs per watch, material 2s., labour 1s., standing charges 2s., total 5s. These are sold at 6s. each in the protected country. Then another 50,000 are put in hand, upon which the standing charges are said to be £1,000, wages and material remaining the same as before, bringing the total cost to 3s. 5d. per watch, and the selling price in England (only) 4s. 1d. Apparently the labour on the watches is the same in each case. In reality, however, it is not. In the £5,000 put down to interest and depreciation on capital outlay, a considerable portion is for labour in making a labour-saving machine to make watches, and is, therefore, payment for labour spent indirectly on watches, the 1s. being for direct labour only. So that the greater the number of watches made the less the labour (direct plus indirect) per watch. In times of slackness, therefore, labour is still being paid for as standing charges even though no watches are made at all. But, no matter how we may regard the figures, the plain fact remains that the Englishman buys precisely the same article more cheaply than the foreigner, and the people who buy them would most probably not have purchased watches at all at the higher price. And as has been shown over and over again, the money does not leave this country, but instead, for each watch imported, material worth 4s. 1d. goes out, and a watch worth 6s., according to Mr. Byng's own figures, comes in. Surely this is good business to the importing country.

Again, I repeat "quantity" does not necessarily pay. What are the latest returns from the countries which work on "quantity" lines and "dump" their surplus into this country?

In 1902 the Schuckert Co. lost nearly £770,000; Lahmeyer & Co. lost in the same year £120,000, and for the year ending March, 1903, shows a loss of £18,584; whilst the Compagnie Internationale d'Electricité, of Liège, shows a loss of £30,604 on the last financial year. Yes, yes! I know the stereotyped reply by heart, but the fact remains that huge exports do not mean prosperity necessarily, but, as already pointed out above, may mean simply the difference between horse-flesh and black bread, and absolute starvation. "Give me protection," says Mr. Byng, "and I will produce in quantities; I will lay out my works on a large scale; specialise every part; adopt piece work throughout; save in supervision in the drawing office, in the counting house and on the commercial side. I will pay higher wages and reduce cost of production." My reply to this is, that without Protection there are works in this country much smaller than Mr. Byng's, who adopt all the methods suggested, and are netting their 20 per cent. profit. Enterprise and business methods are not governed by mere size of works.

This is a manufacturer's question, cries Mr. Byng. Apparently the consumer has no say in the matter. But we are told that "no one who works is a consumer in an economical sense. He must produce before he can consume."

What, then, does the mere landowner produce, for whom Mr. Byng is so solicitous in his book?

"If Free Trade gives cheapness to the consumer, it is wrong to try and attain it at the expense of the producer." But, then, don't you see, Mr. Byng, that if the producer and consumer are one, the consumer who gets something cheap at the expense of the producer gets it at his own expense!

But this is not the producer Mr. Byng wishes to protect; he is thinking of the manufacturer who employs labour largely; and he is imbued with the idea that a manufacturer is something above the common ruck of humanity. He makes work, and the more work he can make the greater benefactor he is to his race. This is the idea. It is quite the reverse of the truth.

Why does a manufacturer buy a labour-saving machine? Not to make more work, but to reduce it, and the more labour it saves the better.

Now a manufacturer is nothing more than a labour-saving device, not a work-providing institution. The boot manufacturer makes our boots to save labour, the tailor does the same. The less labour he employs to meet our needs the better. That is why we employ him instead of making our own things. The saving of labour in every possible way is one of our chief objects in life. Are our manufacturers right then in saying that to save labour by purchasing in the cheaper market is wrong, and that the highest good is "to make work?"

And here I must leave Mr. Byng. Many points I leave untouched simply because it is not worth while to controvert them, for they are too transparent to mislead anyone.

I would, however, like to repeat one or two of the points I previously made, but to which Mr. Byng makes no attempt to reply. I asked how it came about that if protected countries offered such great advantages to the manufacturer, who could send his manufactures free into this country, that so many foreign manufacturers had come over here and built works larger than any existing English works. I looked for a reply to this, feeling sure Mr. Byng had one. But he is silent. And why?

Perhaps we may find the reason in his book. Let us see. Here is a quotation from pp. 34 and 35:—"Do we invite the foreign inventor and manufacturer to settle, and build and work in our country; to teach our workmen, to pay our taxes, to enrich our nation? . . . . We do not! On the contrary, we bribe him to stay away. We open our markets to him so that he may concentrate upon one spot abroad all his big undertakings, and reduce his average expenses and increase his profits. We give him cheaper freights, and handicap against him our own manufacturers."

What a parody on facts, and how typical of the Protectionist's line of argument. No wonder Mr. Byng kept silent.

Another point I hoped and expected he would touch upon,

was the "intellectually, physically and morally, lower than our neighbour" argument, or rather statement.

Intellectually lower! Yet in his book Mr. Byng says:—"But I do protest that an Englishman is as qualified to work a tool or invent a machine as is an American," and again, "electric lighting of private houses, ships, and also central stations originated in this country. The improvements in dynamo winding, making of incandescent lamps, accumulators, transformers, were English. The first electrical tramway and electrical boat were made in England," yet in spite of all this, and many other industries might be cited, Mr. Byng says Free Trade stifles invention, and "has deadened all our old industries, and will not allow new ones to be born."

Why, the whole telephone industry of the world is dependent on Hughes's invention of the microphone (Mr. Byng wrongly gives Edison the credit), and Mr. Byng is at great pains to prove that this industry was killed in England "not by competition, but was smothered by the English laws," and this, forsooth, is one of his strongest chapters against Free Trade!

The "physical" degeneracy argument is apparently based on the falling off in the birth rate.

This may prove just the opposite. The birth rate has merely fallen off because the death rate has.

Any student of animal or vegetable life knows that the struggle for the perpetuation of species depends upon the risks run, and that where the death rate is greatest, so also is the birth rate, and *vice versa*.

But, after all, replying to such arguments is so much beating of the air, and I cannot do better than close with another quotation from Mr. Byng's book. He pictures a man beset by little devils, each bearing the inscription, in letters of fire: "No new industry for 20 years!" One little devil whispers, "*Economically*, the foreigner gets all the profits"; another adds, "*Intellectually*, our brains are getting numbed." He is succeeded by one who says, "*Socially*, skill and knowledge are leaving us," followed by others in turn, who whisper: "*Physically*, we suffer from being compelled to tinker at the same things"; "*Morally*, we are descending to a lower scale of creation"; "*Educationally*, we have no learners, and if we had, we know not what to teach them," "and so on, until the restless sleeper is aroused by the bitterness of the taunts hurled at him, and awakes to find that it is but a dream." A dream, indeed! My dear sir, it is a nightmare, as is proved conclusively by the most recent returns and statistics, and the best service one can render to the sleeper is to shout "Wake up!"

REVIEWS.

The Student's Guide to Submarine Cable Testing. Third (enlarged) edition. By H. K. C. Fisher and J. C. H. Darby. [Copyrighted by the Eastern Extension, Australasia and China Telegraph Co., Ltd.] London: The *Electrician* Printing and Publishing Co., Ltd. Price 7s. 6d. net.

The special object of the authors—as explained in the preface to the first and second editions—is to answer questions frequently put to them when visiting various cable stations of the Eastern Extension Telegraph Co., and to bring together in a compact form information to cover questions relating to cable testing in the yearly examinations for operators in that service.

The third edition embodies Parts I. and II., and also the appendices, of the first and second editions, with occasional additions interpolated in each of these sub-divisions of the book to make them more complete; while, in order not to interfere with the original simple form of the book for junior students, a few tests of a more elaborate nature are given in a new section, Part III.

The additions to Part I. are:—Ayrton and Mather's shunt, transferred from the Appendix of the second edition and extended; Black's CR bridge test by reversals which dispenses with the correction for earth currents; reference to Mr. Alex. Hill's special key for CR measurements to false zero; localising a high resistance fault by CR tests from both ends, by W. J. Murphy; correcting CR by Clark, Forde and Taylor's coefficient for high conductivity copper.

The additions to Part II. include:—Further examples of the Varley and Murray loop test; of Kennelly's test with two currents, balancing to false zero; and of Jordan and Schönan's earth overlap; a graphic method of determining the resistance to be inserted when localising faults by earth overlap, by R. R. Black.

Part III. (which does not appear in earlier editions) contains:—(1) Absolute measurement of capacity; (2) Correcting for galvanometer deflections; (3) Correction for capacity tests; (4) Multiplying power of shunts for swings; (5) Measurement of resistances when Bridge ratio coils are not quite equal.

Besides the addition of Clark, Forde and Taylor's copper coefficient table, the Appendix of the third edition is considerably enlarged by 26 pages of questions and answers relating to the various sections for the student to test his knowledge.

The scope of "The Student's Guide to Submarine Cable Testing" is founded by the requirements of electrical examinations for supervisors, and the ordinary electrical outfit of all the company's stations, and on this account the Kelvin capacity test and Muirhead's correction for Gott's capacity test are left out because they both require special keys; and the Kelvin and Varley slides are also not described because these slides, like the keys, are not supplied to all the cable stations.

In the absence of slides Gott's capacity test has to be made with a fixed resistance of $10{,}000^{\omega}$ and a variable resistance of the same total amount. Whether the capacity test employed be the Gott or Kelvin method, a slide resistance of $100{,}000^{\omega}$ is, of course, very much more suitable to prevent battery polarisation, and, considering its utility as a potentiometer and for several other tests, its description might, with advantage, be included for the benefit of those who have the requisite apparatus.

The favourable reception already accorded to the first and second editions is sufficient proof that "The Student's Guide to Submarine Cable Testing" meets a real want. It is an eminently practical work; the examples given are for the most part actual tests on cables, and the formulæ are simply explained. This alone will recommend it to those who have neither the mathematical nor practical knowledge to discriminate between the variety of alternative methods contained in more advanced and comprehensive text-books.

Without, however, departing from the special object they have kept in view, we venture to suggest that Messrs. Fisher and Darby would enhance the value of their work by adding in a succeeding edition other useful tests and information which do not find a place in the third edition. For instance:—Clark's fall of potential test, which does not entail false zero measurement; Kempe's loss of current fault test; Schaefer's two-current null method for breaks, balancing to scale zero; Rymer-Jones's test for breaks of very high resistance; Murphy's and Kingsford's methods for keeping the current through the fault constant in Blavier's test; DR of a cable by fall of charge; Clark's accumulation joint test; Sullivan's form of Ayrton and Mather's universal shunt.

Messrs. Fisher and Darby appear to evince a rather undue partiality for *false zero* methods. They say "the false zero method is always to be preferred when localising faults except when the fault seals up or polarises with both currents, when quick reversals should be used." Yet in the next paragraph they add: "Mance's method may be used as a check on other tests when localising faults or breaks. The advantage of this method is that it is a *null* method or taken to instrument zero." There is no doubt that testing to false zero is not only a lengthy process, but difficult and uncertain. It was to obviate this that Kennelly introduced his three-current scale zero test for breaks. Moreover, speaking of Mr. C. W. Schaefer's tests, Mr. J. Elton Young says - "He (Schaefer) further suggests that this system of scale zero fault testing, with correction for the measured E C potentials which has been proved to work satisfactorily in his break tests, may be applied to render other methods—such as overlaps—easier of execution, which, with false zero balancing, are frequently found difficult. Considerable skill and judgment are required to balance accurately to false zero,

especially on long cables, whilst a scale zero observation can be made by the inexperienced."

In books containing so many diagrams, formulæ, and figures, printing and clerical errors and oversights must be expected, and the work under review is no exception to the rule, but enforces the necessity of carefully revising the proof sheets, and also the advantage of keeping one's own note-book of testing formulæ of proved accuracy.

One important error is found on page 120. In Kennelly's formula for a fault test with two current strengths, balancing to false zero, the distance of the fault $= \frac{A\sqrt{c} - B\sqrt{c_1}}{\sqrt{c} - \sqrt{c_1}}$.

This is correct, providing that c is the stronger and c_1 the weaker current, and the resistance A obtained with c consequently smaller than resistance B obtained with the weaker current c_1. But immediately after, when substituting the ratio m of the two current strengths for their actual values in milliamperes, they reverse the order and call c the weaker and c_1 the stronger current, or $c = 1$ and $c_1 = m\,c$ instead of $c_1 = 1$ and $c = m\,c_1$. The correct formula should be

$x = \frac{A\sqrt{m} - B}{\sqrt{m} - 1}$ instead of $\frac{B\sqrt{m} - A}{\sqrt{m} - 1}$, or when $c = 4$ and $c_1 = 1$, *i.e.*, a ratio of 4 : 1, $x = 2A - B$ instead of $2B - A$ as is erroneously given.

Again, in the description of the Ayrton and Mather universal shunt, p. 19, Sec. 18A, the diagram connections do not correspond with the text, and a misprint in the process of deducing the MP of the shunt, viz., $\frac{G + R}{S}$, has escaped detection, so that the explanation is confusing. The statement that when employing a universal shunt "the joint resistance of the galvanometer and shunt (S) is always greater than that of the unshunted galvanometer, except when S is the same or less than the galvanometer resistance, is clearly an inadvertence, as one of the examples, viz., when $G = 1{,}000^{\omega}$ and $S = 10{,}000^{\omega}$, correctly shows the joint resistance to be only 909^{ω}. This slip is repeated when it says that "up to the point where $S = G$ the joint resistance is *less* than G, afterwards always *greater*; "whereas under the conditions given, if $S = 9{,}887^{\omega}$ the joint resistance equals $1{,}000^{\omega}$, and any value for S above this, up to 10,000, will give a *less* resistance than the galvanometer.

Attention is called to the fact that with a universal shunt of $10{,}000^{\omega}$ and $7{,}000^{\omega}$ galvanometer resistance the sensitiveness of the instrument is reduced 1·7 times. To obviate this reduction "shunt boxes of higher resistance than $10{,}000^{\omega}$ have been made." It must, however, be borne in mind that a galvanometer of $7{,}000^{\omega}$ would generally be an astatic reflecting galvanometer, the sensitiveness of which can be made to meet all requirements—except for abnormally high resistance measurements—by a fine suspension and raising the controlling magnet. For a Sullivan galvanometer, its coil resistance being generally only $1{,}100^{\omega}$, its sensitiveness is not seriously reduced by a universal shunt of $10{,}000^{\omega}$. In addition to the joint resistance of the shunt and galvanometer having more often to be taken into account as affecting discharge and permanent deflections, a high resistance in circuit with a long cable seriously modifies the electrification fall for the first few minutes when measuring DR, especially when the cable is at a low temperature and the fall very rapid in consequence.

In connection with DR measurement Messrs. Fisher and Darby remark:—"The expression *absolute conductor resistance* and *absolute dielectric resistance* are incorrect in the sense in which we use them, but until others are adopted in cable testing we must continue to use them to prevent confusing the student, who is sure to meet with this very often in cable records." We would suggest adhering to the more usual expression *total DR* and *total CR*.

Referring to G.P. coefficients, a table is given for Willoughby Smith's G.P. coefficient, viz., 1·08 per 1° F. decrease, and Messrs. Fisher and Darby truly say that no two samples of core have the same temperature coefficient. But it is scarcely accurate that the coefficient is "sufficiently accurate for ordinary purposes, especially within 10° of 75° F.," because some gums have a coefficient as high as 1·09, or even higher, which, for reductions from a low temperature, say 35° F., would give a widely different value, viz., 31·4 instead of 22·1 as given in the table.

Attention is drawn on p. 112 to the fact that correcting DR to 75° F. "from the mean temperature calculated from the CR" is not even approximately correct, but no explanation is given as to how the measured DR of a cable, at widely different temperatures, may be reduced to 75° by dividing up the cable into sections and correcting these sections separately for their respective temperatures. Nor is any correction for sea pressure given.

Instead of the student determining the absolute measurement of his condenser capacity, as in Part I. (1), it would be more satisfactory to send a reliable standard condenser the round of the stations periodically—and a bridge also—for comparison; more especially as it is quite possible that the standard resistance of ·25 or ·50 megohm may itself be inexact.

For the Sullivan galvanometer Messrs. Fisher and Darby find the resistance "about 50 per cent. higher for swings [Part III. (4)] than for steady deflections." This apparent increase differs with the galvanometer, and for the very sensitive form of Sullivan for testing on shore, the apparent resistance for swings will sometimes be found as much as ten times as great as for steady deflections.

We congratulate Messrs. Fisher and Darby on the favourable reception their "Student's Guide to Submarine Cable Testing" has met with, and fully realising, as we do, that it is much easier to criticise than to write a good book, we hope that they will receive the foregoing suggestions in the friendly spirit in which we offer them, with a view to amplifying and rendering more complete still an already excellent work.

THE CONTINENTAL ELECTRICAL ENGINEERING INDUSTRY.

Australian Contracts Placed in Germany.

During the first half of the present year three electrical companies were formed in Germany, as compared with four and five respectively in the corresponding periods of 1902 and 1901. The share capital of the three amounts to £305,000, as against £455,500 and £197,000 in the equivalent halves of the two preceding years.

The Helios Co. is reported to have received orders for the supply of large electric-power distributing plant for the Associated Gold Mines (Australia) Co., and for the extension of the municipal central station at Boulder City, Western Australia. The conversion to electric traction of the horse tramway at Valparaiso, and the erection of a water-power station in connection therewith, are to be undertaken by a combination formed of the Siemens-Schuckert Works Co., the A.E.G. and the Union Co., and a syndicate of German bankers. It is intended to establish an independent company to carry on the enterprise, the proposed share capital being £250,000.

The report of the Lahmeyer Electricity Co., of Frankfort-on-the-Maine, which incurred, as mentioned in a previous issue, a loss of £18,000 for the year 1902-3, as against a deficit of £124,000 in the preceding year, states that the amalgamation with the company's trust—the German Company for Electrical Enterprises—has now been completed. Among the machinery supplied during the year are cited the second and third extension plants for the Charing Cross and City Electric Lighting Co. and the equipment for Tata's Hotel, Bombay. As far as the London allied company is concerned, the report states that the latter incurred a loss in 1901 and a loss of a few hundred pounds is also announced for the past year. The Frankfort company is only interested to a slight extent in the English company, and the directors remark that the foreign business has the advantage of disposing of a large portion of the production. With regard to the future, the report mentions that the orders received during the first four months of the new financial year are 50 per cent. greater than in the corresponding period of 1902-3, but an improvement in prices has scarcely been perceptible, and a material alteration in this direction can hardly be expected so long as the productivity of the works is greater than the demand. A change in this respect will also not be brought about by the amalgamation of individual companies, as this only diminishes the number of competitors, but the rivalry continues unchanged, and the directors are of opinion than an improvement is only possible by a general understanding being arrived at on broader principles.

The report for 1902-03 of Körting's Electricity Works Co., of Hanover, points out that there is no truth in the newspaper statements that the Allgemeine Co., of Berlin, has entered into closer relations with the company. These statements are attributed to the negotiations between the firm of Körting Brothers and the A.E.G. in regard to the relinquishment of the former's electrical

manufacturing department. As may be remembered, Körting's Electricity Works Co. was established a few years ago by the firm of that name, to take over and carry on the central stations and large isolated plants built by the firm. The latter guaranteed the payment of interest on the company's capital for several years and now proposes to terminate the guarantee in March, 1905. The net profits of the company for the past financial year amount to £9,523, and a dividend at the rate of 6 per cent., as in the previous year, is to be paid to the shareholders.

The Voltohm Electricity Co, of Frankfort-on-the-Maine, which was formed in 1898, to take over the electro-technical business of the Voltohm Co., of Munich, acquired shortly afterwards the wire rope works of J. Reutlinger, and the telegraph wire and cable factory of E. Blust, at Frankfort. In 1899, the company, which has a share capital of £37,500, paid a dividend at the rate of 7 per cent., and in the following year the distribution was 4 per cent.; but since then losses have been incurred, and the deficit at the end of 1902 amounted to £7,500. The directors have found that the construction of arc lamps and Roentgen apparatus does not work in well with the manufacture of wire ropes and cables, and they have decided to sell the former branches to Herr Louis Rosenthal, of Furth, Bavaria. The shareholders have just approved this arrangement and the alteration of the title to the Voltohm Rope and Cable Works Co.

Among other German enterprises may be mentioned the Rheydt Cable Works Co. which proposes a dividend at the rate of 12 per cent. for the past year as compared with 10 per cent.; the profit of £12,300 earned by the German Cable Works Co. is to be devoted, after providing for depreciation, to the complete extinction of the deficit from the previous year; and the deficiency of the Westinghouse Electricity Co., which amounted to £9,396 in 1901, has increased to £17,511 during the past year.

The Compagnie Général de Traction, notwithstanding the drastic scheme of reorganisation which has been carried out, has not yet emerged from the difficulties which have surrounded it for a long time past. It was found necessary a year ago to write down the share capital by no less than £840,000 in consequence of heavy losses due to decline in the value of securities and the unremunerativeness of several of the electric tramways in which the company is interested both in Paris and the provinces; and the year 1902 has now terminated with a fresh loss of £136,000. The share capital of the company is at present £424,000, the bonded debt amounts to £452,000 and the loan debt to £582,000. The directors state that a financial improvement has taken place in the condition of the various provincial tramways as a result of the transfer of the management of those lines to an independent company for a period of three years, and progress is also hoped for in the tramways in Paris. The maintenance of the Diatto surface contact system on certain of the lines of the East Parisian, the West Parisian, and the left bank of the Seine still necessitates a considerable outlay, but it is expected to obviate this expense in course of time by the substitution of the overhead trolley system, which is extending in the French capital.

The Bank for Electrical Enterprises of Zurich, which was founded in 1896 by the Berlin Allgemeine Co. for the financing of undertakings in which the latter is interested mainly as a contractor, has a share capital of £1,320,000 and a bonded debt of £1,290,000. Until recently the Berlin A.E.G. held £1,270,000 of the ordinary capital of the bank, although the shares were entered at £727,500 in the company's last balance-sheet, but as certain Berlin banks are now offering shares of the Zurich company for sale, it would appear that the A.E.G. is reducing its holding in that enterprise. The Swiss Bank, which is interested in various electric tramways, lighting stations, chemical works, &c., in European and other countries, has earned net profits amounting to £98,000 during 1902-03, as compared with £89,400 in the previous year. The dividend which has been declared is at the rate of 6½ per cent., as against 6 per cent. in 1901 and 1900, 6½ per cent. in 1899 and 6 per cent. in 1898.

ON A NEW METHOD OF TUNING WIRELESS TELEGRAPH STATIONS BY MEANS OF THE "MULTIPLIER."*

By COUNT ARCO.

(*Concluded from page* 438.)

From these experiments it appears that it is quite possible to tune receivers with sufficient accuracy for practical purposes, and further that the method offers a very simple and effective means of determining wave lengths and frequencies without delicate apparatus. An accuracy of ½ to 2 per cent., with a little dexterity, can easily be attained, even without the use of a spark-micrometer.

For reducing the quarter-wave lengths found by the coil measurement to their corresponding values in a simple aerial conductor, we deduced (within the range of our experiments) the constant factor 0·84—that is, from the value in metres found with the "unloaded" coil, the quarter-wave length in the aerial wire may be determined by simply multiplying the coil length in metres by 0·84.

The experimental results further show that whereas when the transmitter is directly excited (fig. 8) the fundamental vibrations have only *one* period, there are always vibrations of two different frequencies when the aerial wire is thrown into vibration by a tuned exciting circuit. The frequency which is practically useful is that which pulsates through the inductance coil of the aerial conductor; the corresponding wave-length is identical with the only one produced when the excitation is direct.

When the exciting circuit is out of tune a third frequency occurs in the aerial conductor—namely, that of the discordant exciting circuit. This has not been observed in distant working.

5.—Application of the Process in other Electric Measurements.

In conclusion, one or two other applications of the multiplier may be noticed. We can, for example, by its means determine the increase of *damping* of an exciting circuit when electric energy is abstracted from it by connection with the earth and a tuned aerial wire capable of radiation. We can also determine the reaction of

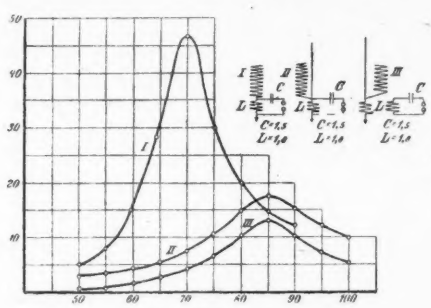


Fig. 17.

the aerial conductor system upon the exciting circuit—that is, the amount by which the fundamental rate of vibration of the jar circuit is diminished by connecting with it a counterpoise and tuned aerial wire. The capacity of the exciting circuit is thus increased by a definite amount—the capacity of the parallel aerial wire—and its rate of vibration decreased. These experiments are shown in figs. 17 and 18. Fig. 17 (I.) shows a jar circuit made up of a capacity

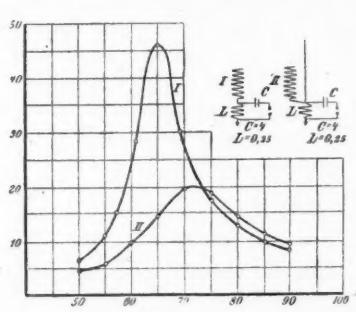


Fig. 18.

of 0·003 mf. and 1·8 turns. This is earthed at one point, and the multiplier is connected as shown. The measured wave-length is given in curve I. The tuned aerial wire was then connected, either directly (II.) or inductively (III.) with the jar circuit, and the wave-length again measured with the multiplier. The values obtained are shown in curves II. and III. From these curves we see that—

1. The amplitude of the potential at the multiplier has dropped to about one-third, that is, the damping of the jar circuit is considerably increased.

2. That the wave-length is increased by the direct attachment of the aerial wire as well as by the inductive connection, in the ratio of 85 : 70 = 1·2, and

3. With the inductive coupling, in which the multiplier was connected with the separate aerial wire system, the energy vibrating in the aerial wire was less than when the aerial wire was directly connected with the jar circuit in the ratio of 13 : 17½, or by about 30 per cent.

In this experiment the inductive coupling was too loose, the loss in transformation too great.

In fig. 18 the same experiments with the connections shown in I. and II. are repeated, with the difference that the capacity was about 2·6 times as great as in fig. 17. The curves show that in this case:—

1. The reaction of the aerial wire on the jar circuit, and the difference of frequency caused by the addition of the capacity of the aerial wire to the jar circuit is smaller. The retardation is only about 72 : 65 = 1·11.

2. That the damping, due to the increase of the condenser capacity contained in the jar circuit, and the increased amount of vibrating energy which this gives rise to in the exciting circuit, is less than when the small condensers are used, as in fig. 15. The increase of damping is now, in fact, only in the ratio of the amplitude — 46 : 20 = 2·3; but with the smaller condensers as in fig. 17 in the ratio of 46 : 17·5 = 2·63.

From the fact that the aerial wire reacts upon the frequency of the exciting circuit, it might be inferred that the connection of the

* Translation of article in the *Elektrotechnische Zeitschrift*, January 1st, 1903.

multiplier itself with the exciting circuit would result in an alteration of the wave-length. In this case the wave-length measured

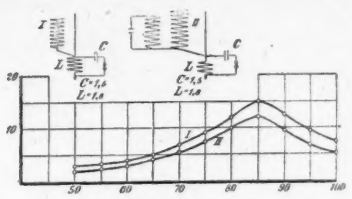


Fig. 19.

with the multiplier would be too great, and a correction would have to be applied. The question is investigated in fig. 19. The wave-length was measured with the multiplier with an aerial wire attached (Curve I.). Then a second multiplier loaded with the coherer capacity was added, and the wave-length, determined by the first coil, again checked. Curves I. and II. show that the multiplier *does not produce a variation of the wave-length.* In both cases the quarter-wave length is exactly 85. It should be observed, however, that the measuring coil abstracts an appreciable quantity of energy from the jar circuit; this is shown by the diminution of the amplitude in the ratio of 15 to 12. Of course this absorption of energy is considerably less than when the aerial wire is attached.

A further possible application of the coil is for the measurement of small capacities. P. Drude measured the capacity of a vacuum tube in this way.

For this purpose the coil loaded with unit capacity is joined up with an earth-connected Leyden jar circuit with counter-poise and adjusted until resonance is obtained. The capacity is then replaced by the capacity to be measured. Let L_1 and L_2 be the inductances, c_0 the unit capacity, and x the capacity to be measured; then by Thomson's law

$$x = c \frac{L_1}{L_2}.$$

The ratio $L_1 : L_2$ may be found by means of a standard curve from the number of turns (w_1 and w_2) in each case. For coils in which the ratio of length to diameter is great, and also c_0 and x do not differ too widely, we may without much error assume that

$$L_1 : L_2 = w_1 : w_2.$$

THE EVIDENCE ON MUNICIPAL TRADING.

The minutes of evidence upon which the Joint Committee based their Report on Municipal Trading are now in the hands of the public, and very fully support the conclusions arrived at upon the branch of the subject to which they limited their inquiry. The evidence of the Permanent Secretary of the Local Government Board furnished the necessary statistics to date as to municipal loans and the character of the trading operations carried on, and then dealt with the question of audit of the accounts, pointing out that they are "*not kept on what are called commercial lines—that is to say, would not show a profit and loss account.*"

This authoritative statement will astonish ratepayers who have accepted the statements put forward by the advocates of municipal trading with reference to the alleged profits made on municipal electric supply undertakings. In certain much-quoted tables summarising the trading results there is a column in which the surplus or deficit in the accounts prepared by the municipalities is shown, and these figures are accepted without question as conclusive evidence of the position of the undertakings.

That these statements are absolutely fallacious we have frequently pointed out; and it is satisfactory to learn from Sir Samuel Butler Provis's evidence that the Local Government Board have under consideration necessary alterations in the accounts of municipal undertakings in order to show not merely actual receipts and payments during the particular year, but income and expenditure in respect of the undertaking.

The Islington electric supply undertaking is a good illustration of the necessity for a statement of accounts which would show the actual position of the trading on the whole, apart from the mere income and expenditure for the current year. Thus, without going into the question of the method of keeping the accounts, provision for depreciation, charge for public lighting, &c., the results stated by the authority show profits in some years and losses in others, viz., in 1900 a loss of £3,116, in 1902 a profit of £2,089, and in 1903 a loss of £1,740.

The accounts recently published by the Urban District Council of Wimbledon are the subject of keen criticism in the locality, and afford another example of the necessity for the system of audit recommended by the Joint Select Committee. The Council show by their method of preparing the accounts that there was a profit for the year ending March 31st last, of £2,027 19s. 8d., out of which £500 is carried to reserve fund, and £1,527 19s. 8d. in relief of rates.

This a very rosy statement, calculated to gratify the ratepayers, and will, no doubt, be used by municipal traders in support of their views; but one of the ratepayers, a Mr. H. Crickmay, with an evident knowledge of figures, has given another side to the picture, and his statements are of especial interest. He briefly points out that the total units generated and accounted for were 1,030,212. The total cost, including repayment of debt and interest, was £13,425 2s. 11d., and the cash income earned, £10,068 14s. 10d. Consequently there was a deficiency of £3,356 8s. 1d. This had to be raised from the rates, in order that bills due could be liquidated within the year; in spite of which the Council apply £1,527 19s. 8d. to the local rates, an action which is obviously calculated to deceive the ratepayers as to the actual result of the trading.

Mr. Crickmay shows the actual cash account of the business as follows:—

Total cost	£13,425	2	11
Cash receipts of all sorts	10,068	14	10
Raised from rates	3,356	8	1
	£13,425	2	11

There is no cover for reserve fund or profit, and these, it is pointed out, are shown (on paper) by crediting the working cost of the public lighting, amounting to £5,403 11s. 2d.

If all localities possessed competent and willing critics of the accounts of the local authority, ratepayers would soon realise the necessity for a Local Government Board auditor to protect them from their representatives, who, while strictly honest, are, too often, far from being competent accountants.

Sir Samuel Butler Provis strongly advocated the appointment of auditors chosen by an outside authority, with power of dealing with an illegal expenditure by means of surcharge on the spot, such, for instance, as *overdraft.*

Mr. Albert Gray, counsel to the Lord Chairman of the House of Lords, hit the nail on the head when he said that an effective system of municipal audit would go very far towards removing the evil results of trading on the part of municipalities, because of the temptation to present accounts in a form which makes the enterprise appear more productive than it is, and the temptation is the stronger because of there being no effective or efficient audit.

The borough accountant of Burton-on-Trent, writing on the subject of depreciation, lays down a sound principle when he says: "It appears quite clear to me that various items in the electrical equipment and machinery have not an equivalent life to the period granted for the original loan, and steps should be taken to maintain the undertaking without recourse to further borrowing, except for new works."

A similar opinion is expressed by the borough treasurer of Kingston-upon-Hull, who thinks it "advisable, seeing that local authorities have no share capital wherewith to meet contingencies, that a reserve fund should be provided, according to the exigencies of the circumstances, to meet any extraordinary charge that may arise and prevent the general ratepayer having to bear any portion of the cost of maintaining undertakings which should be self-supporting." He goes even further by holding that "provision should also be made for eventually meeting the natural growth of any undertaking out of its own revenue or reserve funds."

To think it possible that revenue can not only provide for the working expenditure, the maintenance of the plant, depreciation, obsolescence, and the capital required for the extension of the undertaking, is, we fear, carrying the probability of profits to an impossible extent.

It is, however, satisfactory to find among municipal finance officials sound principles of accountancy in support of the views of the Joint Select Committee, as indicated in their recommendations.

The evidence of Mr. Welton, past-president of the Institute of Chartered Accountants and chairman of the Finance Committee of the Wandsworth Borough Council, is of considerable interest, as it is that of a well-known expert in accountancy who is familiar with the accounts of local authorities. He is strong upon the question of depreciation, and especially of provision for obsolescence, forcibly illustrating the latter point by the position of a canal superseded by railways with a consequent wastage without its falling out of repair, and in like manner instanced the result of competition between gas and electricity. He defines true profits as being arrived at after paying the ordinary expenses, depreciation arising from wastage, and provision for the obsolete. He says that if depreciation is not provided for, the profits appear to be greater than they actually are, and contends that there should be a balance-sheet of the municipal account showing the assets and liabilities at the date of the account.

Although the Joint Committee decided upon practically limiting their inquiry to the question of municipal accounts and audit, they made a notable exception in the case of Sir Andrew Noble, who gave most valuable evidence on the question of municipal trading, to which we may refer more particularly before closing our comments upon the report. In his opinion it would be best if municipalities could be prevented from trading altogether, except in regard to matters such as the disposal of sewage, where there may be serious difficulties in getting private enterprise to undertake to do what is necessary.

(To be continued.)

Belgium.—La Compagnie d'Electricité de Seraing et Extensions is the name of a company which has just been formed with a capital of £48,000 to exploit the concession for supplying electrical energy for lighting and power purposes at Seraing, near Liège, where are situated the large steel and engineering works of the Cockerill Co.

NEW PATENTS APPLIED FOR, 1903.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

18,710. "Chambers for the combustion of fuel under pressure; valves, purifiers, loading apparatus, and air compressors in connection therewith; means for applying the gaseous products to smelting, steel making and the production of electricity." D. Cook. August 31st.

18,712. "A double point for electric rails of the conduit system, so that the car can always pick up the current." A. C. Holbrow. August 31st.

18,713. "Automatic working of points of electric tramways." A. C. Holbrow. August 31st.

18,731. "Improvements in electrical switches." H. Crowe. August 31st.

18,740. "A method of actuating switches or the like." W. E. Evans. (Allgemeine Elektricitäts-Gesellschaft, Germany.) August 31st. (Complete.)

18,745. "Improvements in and relating to excess indicators for use with an electric current." L. B. Atkinson. August 31st.

18,754. "Improvements in semi-automatic telephone systems." E. A. Faller. August 31st. (Complete.)

18,755. "Improvements in or relating to electrical indicating apparatus for communicating and recording instructions." H. Blender. August 31st. (Complete.)

18,829. "Improvements in electric insulators." W. E. Langdon, J. G. Fuller, and G. Fuller. September 1st.

18,854. "Improvements in and relating to telegraphic recording and perforating apparatus." J. T. Armstrong. September 1st.

18,860. "Improvements in and relating to electrical switches." L. M. Casella. September 1st.

18,867. "Improved telegraph apparatus." O. Imray. (Societé des Telegraphs Multiplex (Systeme E. Mercadier, France.) September 1st. (Complete.)

18,907. "Improvements in electrical controllers." W. Fairweather. (Diehl Manufacturing Co., United States.) September 2nd. (Complete.)

18,934. "Improvements in electric storage batteries or accumulators." H. Pratt and F. Vince. September 2nd.

18,953. "Improved check or indicator applicable to the electric controllers of electrically-driven vehicles." A. R. L. Wille. September 2nd. (Complete.)

18,958. "Improvements in and relating to electrolytic manufacture of caustic soda and other products." J. B. Hannay. September 2nd.

18,964. "Improvements relating to the regulation of the voltage of dynamos." C. Turnbull, jun. Dated September 3rd.

18,980. "Improvements in and connected with electrical signalling on railways and tramways." J. W. Tunstall. September 3rd.

18,998. "Electric current generating and motive-power machine." W. S. Frost. September 3rd.

19,012. "Improvements in electric lampholders." V. Zingler. September 3rd.

19,015. "Improvements in contacts, especially suitable for induction coils." Marconi's Wireless Telegraph Co., Ltd., and E. Priddle. September 3rd.

19,029. "Improvements in switch trolley heads for electric cars." J. H. A. McGuire. September 4th.

19,053. "Improved method of guiding trolley-heads along frogs and crossings attached to overhead wires in connection with electric railways and tramways." H. Cooley. September 4th.

19,054. "Improvements in and applicable to overhead equipment, electric or otherwise, of railways and tramways to work in connection with railway carriages, tramway car or cars, or vehicle or vehicles, truck, trucks, or part, or parts of the same." W. P. W. Weatherill. September 4th.

19,063. "Improvements in and relating to electro-capillary detectors, relays and recording apparatus." J. T. Armstrong and A. Orling. September 4th.

19,065. "Improvements in or relating to electrical measuring instruments." C. E. Foster, E. R. Grote, and M. V. Ely. September 4th.

19,092. "Improvements in electrical locking apparatus for railway signals." W. R. Sykes, Jun. September 4th.

19,130. "Improvements in incandescent gas and electric globe lamps." J. W. Lea and J. H. Perrins. September 5th.

19,142. "Improved driving and speed regulating mechanism for dynamo-electric generators when carried by railway and other vehicles." A. T. Metcalf. September 5th.

19,172. "Improvements in apparatus for controlling the working of electrically-driven cars." Siemens Bros. & Co., Ltd., and F. Lydall. September 5th. (Complete.)

PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

1902.

418. "Improvements in or connected with thermo-electric batteries." B. J. Hall. Dated January 7th.

493. "Improvements in electrical demand or rebate indicators." F. Lux and Reason Manufacturing Co. Dated January 7th.

561. "Improvements relating to electrical heating apparatus." British Westinghouse Electric and Manufacturing Co. (J. S. Peck, Pittsburg; K. C. Randall, Wilkinsburg; and C. F. Scott, Pittsburg, U.S.A.) Dated January 8th.

577. "Improvements in insulators." L. Hackethal. Dated January 8th.

609. "Improvements in electrical switches and cut-outs." R. F. Hall. Dated January 9th.

667. "Improvements in connection with surface contact electric traction systems working with magnetically-operated switches." Dolter Electric Traction. (H. Dolter, Paris.) Dated January 9th.

697. "Improvements in and connected with apparatus for the reception of sound signals for nautical and other purposes." E. de Meulemeester. Dated January 9th.

750. "Improvements in wireless telegraphy." S. G. Brown. Dated January 10th.

1,767. "Improved devices for varying the speed of continuous current electric motors." A. G. Bloxam. (Couffinhal et ses Fils, France.) Dated January 22nd.

1,772. "Improvements relating to telephone systems." E. P. Baird. Dated January 22nd.

1,820. "An improved method of laying cables." G. C. Hurrell. Dated January 23rd.

1,874. "Improvements in controllers for electric motors." T. S. Perkins. Dated January 23rd.

1,888. "Improvements in systems of electrical distribution." B. Hopkinson. Dated January 24th.

1,984. "An improved electric transformer. W. T. Stutchbury and C. Gorick. Dated January 24th.

2,018. "Improvements in junction boxes for electric wiring." J. Waldron and E. White. Dated January 25th.

2,019. "An improved coupling socket for electric wiring." J. Waldron and E. White. Dated January 25th.

2,024. "Improvements in collectors for electrically-propelled vehicles." A. Hill. Dated January 25th.

2,034. "Improvements in electric arc lamps." H. Baggett. Dated January 25th.

10,008. "Improvements in intercommunication telephones." G. E. Beckett. Dated April 30th.

10,533. "Improvements in and relating to drawings or matrices for use in electric Jacquard punching and similar machines." O. Zerkowitz. Dated May 7th.

10,733. "Improvements in automatic electric regulating or controlling devices or systems." W. Stockmeyer. Dated May 9th.

10,889. "Improvements in or relating to telephone receivers and transmitters." W. C. Runge. May 12th.

11,815. "Improvements in or connected with the return circuit on electric railway systems." H. H. Lake. (General Electric Co.) May 24th.

11,816. "Improvements in or relating to variable speed electro-motors." H. H. Lake. (General Electric Co.) Dated May 24th.

11,818. "Improvements in electric switches." H. H. Lake. (General Electric Co.) May 24th.

11,840. "Improvements in cleats or holders for electric conductors." H. H. Lake. (General Electric Co.) Dated May 24th.

12,081. "Improvements relating to lubricating devices for the trolley-wheels of electric railway cars and the like." H. H. Lake. (General Electric Co.) Dated May 24th.

12,159. "Improvements in the manufacture of filaments or the like for electric incandescence lamps." C. D. Abel. (Siemens & Halske Aktien-Gesellschaft.) Dated May 23rd.

12,700. "Improvements relating to the manufacture of active material for the plates of electric accumulators." S. A. Rosenthal. Dated June 3rd.

13,741. "Improvements in and relating to electric switches." H. H. Lake. (General Electric Co.) Dated June 17th.

13,743. "Improvements in motor controlling devices." H. H. Lake. (General Electric Co.) Dated June 17th.

13,792. "A new or improved fault-indicator for electric circuits." M. B. Field. Dated June 18th.

13,877. "Improvements in or relating to electric railways or a road contact or sectional conductor systems." A. J. Boult. (L. Negro.) Dated June 18th.

14,133. "Improvements in connecting carbon electrodes with electric leads." H. Baker and Castner-Kellner Alkali Co., Ltd.) Dated June 21st.

14,140. "Improvements in electrical power factor indicators." H. H. Lake. (General Electric Co.) Dated June 21st.

14,294. "Improvements in or relating to regulating devices for dynamo-electric machines." H. H. Lake. (General Electric Co.) Dated June 24th.

14,295. "Improvements in electric protection devices." H. H. Lake. (General Electric Co.) Dated June 24th.

14,296. "Improvements in and relating to systems of electrical distribution." H. H. Lake. (General Electric Co.) Dated June 24th.

14,583. "Improvements in electrolytic interrupters." G. E. Gaiffe and G. Gallot. Dated June 30th.

14,732. "Improvements in magneto-electric generators or dynamos." T. B. Murray and N. O. Fulton. Dated July 2nd.

28,805. "Improvements in galvanic batteries." Halsey Electric Generator Co., Ltd. (Halsey Electric Generator Co., U.S.A.) Dated December 30th.

28,807. "Improvements in galvanic batteries." Halsey Electric Generator Co., Ltd. (Halsey Electric Generator Co.) Dated December 30th.

1903.

4,709. "Electrically driven vertical saw frames for cutting wood." J. Barr, of the firm of J. Mc Dowall & Sons, and R. Anderson. Dated February 28th.

4,735. "Improvements in and connected with safety fuses." G. W. Norres. Dated February 28th.

4,886. "Improvements in commutators for continuous current machines." Siemens Bros. & Co., Ltd. (Siemens & Halske Aktiengesellschaft, Germany.) Dated March 2nd.

4,969. "Improvements in electric arc lamps." T. E. Adams. Dated March 3rd.

5,030. "Electrically-driven circular saw bench for cutting wood and the like." J. Barr, of the firm of J. McDowall & Sons, and R. Anderson. Dated March 4th.

5,081. "Improvements in galvanic batteries." A. I. Jacobson. Dated March 4th.

5,224. "Electrically-driven vertical saw frames for cutting wood." J. Barr, of the firm of J. McDowall & Sons, and R. Anderson. Dated March 6th.

5,314. "Improvements in field-magnets for dynamo-electric machines or electric motors." R. Lundell. Dated March 6th.

6,060. "Improvements in the manufacture of electrodes for electric arc lamps." O. Blondel. (Date applied for under Patents Act, 1901, April 8th, 1903, being date of application in United States.) Dated March 16th.

6,061. "Improvements in electrodes for electric arc lamps." A. Blondel. (Date applied for under Patents Act, 1901, April 24th, 1902, being date of application in Belgium.) Dated March 16th.

6,098. "Improvements in electric motor-generators and other dynamo-electric machines." E. S. W. Moore and T. L. Boyden. Dated March 16th.

6,106. "Improvements in revolving fields for electric generators or motors." W. A. Johnson. Dated March 16th.

6,288. "Improvements in windings for electrical transformers." J. S. Peck. (Date applied for under Patents Act, 1901, March 21st, 1902, being date of application in United States.) Dated March 18th.

6,366. "Improvements in casings and globe holders for electric lamps." A. Kusebauch. (Date applied for under Patents Act, 1901, March 21st, 1902, being date of application in the United States.) Dated March 19th.

6,367. "Improvements in brake apparatus for electrically-propelled railway vehicles." F. C. Newell. Dated March 19th. (Date applied for under Patents Act, 1901, March 29th, 1902, being date of application in United States.)

6,368. "Improvements in brake apparatus for electrically-propelled railway and tramway vehicles." F. C. Newell. Dated March 19th. (Date applied for under Patents Act, 1901, April 1st, 1902, being date of application in United States.)

6,740. "Method and apparatus for photographically recording characters in printing telegraphs." Siemens Bros. & Co., Ltd. (Siemens & Halske Aktiengesellschaft, Germany.) Dated March 23rd.

6,741. "Improvements in telephonic exchanges." Siemens Bros. & Co., Ltd. (Siemens & Halske Aktiengesellschaft, Germany.) Dated March 23rd.

6,742. "Method and apparatus for telegraphically recording type-written characters." Siemens Bros. & Co., Ltd. (Siemens & Halske Aktiengesellschaft, Germany.) Dated March 23rd.

6,832. "Improvements in electrical measuring instruments." T. W. Varley. Dated March 24th.

6,911. "Improvements in adjustable electric light pendants or fittings." H. McGowan. Dated March 25th.

6,952. "Improvements in electric igniters for internal combustion engines." G. A. Goodson. Dated March 25th.

6,953. "Improvements in electric igniters for internal combustion engines." G. A. Goodson. Dated March 25th.